In [2]:

```
%matplotlib inline
import warnings
warnings.filterwarnings("ignore")
from matplotlib_venn import venn2
from nltk.probability import FreqDist
from scipy.stats import spearmanr
from matplotlib import gridspec

import plotly.graph_objs as go
import pandas as pd
import numpy as np
import plotly.offline as py
import nltk
import string
import matplotlib.pyplot as plt
import seaborn as sns
from sklearn.feature_extraction.text import TfidfTransformer
from sklearn.feature_extraction.text import TfidfVectorizer

from sklearn.feature_extraction.text import CountVectorizer
from sklearn.metrics import confusion_matrix
from sklearn import metrics
from sklearn.metrics import roc_curve, auc
from nltk.stem.porter import PorterStemmer

import re
# Tutorial about Python regular expressions: https://pymotw.com/2/re/
import string
from nltk.corpus import stopwords
from nltk.stem import PorterStemmer
from nltk.stem.wordnet import WordNetLemmatizer

from gensim.models import Word2Vec
from gensim.models import KeyedVectors
import pickle
import cufflinks as cf
cf.go_offline()
cf.set_config_file(offline=False, world_readable=True)

import tensorflow as tf
from transformers import *
import lightgbm as lgb
from sklearn.model_selection import GroupKFold
import tensorflow.keras.backend as K

from tqdm import tqdm
import os
```

In [1]:

```
! pip install transformers
```

```
Collecting transformers
  Downloading https://files.pythonhosted.org/packages/48/35/ad2c5b1b8f99feaa
f9d7cdadaeef261f098c6e1a6a2935d4d07662a6b780/transformers-2.11.0-py3-none-an
y.whl (https://files.pythonhosted.org/packages/48/35/ad2c5b1b8f99feaaf9d7cda
daeef261f098c6e1a6a2935d4d07662a6b780/transformers-2.11.0-py3-none-any.whl)
 (674kB)
     |████████████████████████████████| 675kB 2.8MB/s
Requirement already satisfied: regex!=2019.12.17 in /usr/local/lib/python3.
6/dist-packages (from transformers) (2019.12.20)
Collecting sacremoses
  Downloading https://files.pythonhosted.org/packages/7d/34/09d19aff26edcc8e
b2a01bed8e98f13a1537005d31e95233fd48216eed10/sacremoses-0.0.43.tar.gz (http
s://files.pythonhosted.org/packages/7d/34/09d19aff26edcc8eb2a01bed8e98f13a15
37005d31e95233fd48216eed10/sacremoses-0.0.43.tar.gz) (883kB)
     |████████████████████████████████| 890kB 9.6MB/s
Requirement already satisfied: numpy in /usr/local/lib/python3.6/dist-packag
es (from transformers) (1.18.5)
Requirement already satisfied: dataclasses; python_version < "3.7" in /usr/l
ocal/lib/python3.6/dist-packages (from transformers) (0.7)
Requirement already satisfied: packaging in /usr/local/lib/python3.6/dist-pa
ckages (from transformers) (20.4)
Requirement already satisfied: tqdm>=4.27 in /usr/local/lib/python3.6/dist-p
ackages (from transformers) (4.41.1)
Collecting sentencepiece
  Downloading https://files.pythonhosted.org/packages/d4/a4/d0a884c4300004a7
8cca907a6ff9a5e9fe4f090f5d95ab341c53d28cbc58/sentencepiece-0.1.91-cp36-cp36m
-manylinux1_x86_64.whl (https://files.pythonhosted.org/packages/d4/a4/d0a884
c4300004a78cca907a6ff9a5e9fe4f090f5d95ab341c53d28cbc58/sentencepiece-0.1.91-
cp36-cp36m-manylinux1_x86_64.whl) (1.1MB)
     |████████████████████████████████| 1.1MB 18.7MB/s
Collecting tokenizers==0.7.0
  Downloading https://files.pythonhosted.org/packages/14/e5/a26eb4716523808b
b0a799fcfdceb6ebf77a18169d9591b2f46a9adb87d9/tokenizers-0.7.0-cp36-cp36m-man
ylinux1_x86_64.whl (https://files.pythonhosted.org/packages/14/e5/a26eb47165
23808bb0a799fcfdceb6ebf77a18169d9591b2f46a9adb87d9/tokenizers-0.7.0-cp36-cp3
6m-manylinux1_x86_64.whl) (3.8MB)
     |████████████████████████████████| 3.8MB 13.9MB/s
Requirement already satisfied: requests in /usr/local/lib/python3.6/dist-pac
kages (from transformers) (2.23.0)
Requirement already satisfied: filelock in /usr/local/lib/python3.6/dist-pac
kages (from transformers) (3.0.12)
Requirement already satisfied: six in /usr/local/lib/python3.6/dist-packages
(from sacremoses->transformers) (1.12.0)
Requirement already satisfied: click in /usr/local/lib/python3.6/dist-packag
es (from sacremoses->transformers) (7.1.2)
Requirement already satisfied: joblib in /usr/local/lib/python3.6/dist-packa
ges (from sacremoses->transformers) (0.15.1)
Requirement already satisfied: pyparsing>=2.0.2 in /usr/local/lib/python3.6/
dist-packages (from packaging->transformers) (2.4.7)
Requirement already satisfied: chardet<4,>=3.0.2 in /usr/local/lib/python3.
6/dist-packages (from requests->transformers) (3.0.4)
Requirement already satisfied: urllib3!=1.25.0,!=1.25.1,<1.26,>=1.21.1 in /u
sr/local/lib/python3.6/dist-packages (from requests->transformers) (1.24.3)
Requirement already satisfied: idna<3,>=2.5 in /usr/local/lib/python3.6/dist
-packages (from requests->transformers) (2.9)
Requirement already satisfied: certifi>=2017.4.17 in /usr/local/lib/python3.
6/dist-packages (from requests->transformers) (2020.4.5.2)
```

```
Building wheels for collected packages: sacremoses
  Building wheel for sacremoses (setup.py) ... done
  Created wheel for sacremoses: filename=sacremoses-0.0.43-cp36-none-any.whl
size=893260 sha256=a1b853404e9d4bb4066d32a660ade943a4272b620f2682e7085ffb95b
b252321
  Stored in directory: /root/.cache/pip/wheels/29/3c/fd/7ce5c3f0666dab31a501
23635e6fb5e19ceb42ce38d4e58f45
Successfully built sacremoses
Installing collected packages: sacremoses, sentencepiece, tokenizers, transf
ormers
Successfully installed sacremoses-0.0.43 sentencepiece-0.1.91 tokenizers-0.
7.0 transformers-2.11.0
```

Reading data

In [ ]:

```
print('Reading data...')
train_data = pd.read_csv('train.csv')
test_data = pd.read_csv('test.csv')
sample_submission = pd.read_csv('sample_submission.csv')
print('Reading data completed')
```

```
Reading data...
Reading data completed
```

In [ ]:

```
print('Size of train_data', train_data.shape)
print('Size of test_data', test_data.shape)
print('Size of sample_submission', sample_submission.shape)
```

```
Size of train_data (6079, 41)
Size of test_data (476, 11)
Size of sample_submission (476, 31)
```

In [ ]:

```
train_data.head()
```

Out[5]:

	qa_id	question_title	question_body	question_user_name	question
0	0	What am I losing when using extension tubes in...	After playing around with macro photography on...	ysap	https://photo.stackexchange.con
1	1	What is the distinction between a city and a s...	I am trying to understand what kinds of places...	russellpierce	https://rpg.stackexchange.con
2	2	Maximum protusion length for through-hole comp...	I'm working on a PCB that has through-hole com...	Joe Baker	https://electronics.stackexchange.com/
3	3	Can an affidavit be used in Beit Din?	An affidavit, from what i understand, is basic...	Scimonster	https://judaism.stackexchange.con
4	5	How do you make a binary image in Photoshop?	I am trying to make a binary image. I want mor...	leigero	https://graphicdesign.stackexchange.c

5 rows × 41 columns

In [ ]:

```
test_data.head()
```

Out[6]:

	qa_id	question_title	question_body	question_user_name	que
0	39	Will leaving corpses lying around upset my pri...	I see questions/information online about how t...	Dylan	https://gaming.stackexchange
1	46	Url link to feature image in the portfolio	I am new to Wordpress. i have issue with Featu...	Anu	https://wordpress.stackexchange
2	70	Is accuracy, recoil or bullet spread affected ...	To experiment I started a bot game, toggled in...	Konsta	https://gaming.stackexchange
3	132	Suddenly got an I/O error from my external HDD	I have used my Raspberry Pi as a torrent-serve...	robbannn	https://raspberrypi.stackexchange
4	200	Passenger Name - Flight Booking Passenger only...	I have bought Delhi-London return flights for ...	Amit	https://travel.stackexchange

In [ ]:

```
sample_submission.head()
```

Out[7]:

	qa_id	question_asker_intent_understanding	question_body_critical	question_conversational
0	39	0.00308	0.00308	0.00308
1	46	0.00448	0.00448	0.00448
2	70	0.00673	0.00673	0.00673
3	132	0.01401	0.01401	0.01401
4	200	0.02074	0.02074	0.02074

5 rows × 31 columns

In [ ]:

```
train_data.columns
```

Out[8]:

```
Index(['qa_id', 'question_title', 'question_body', 'question_user_name',
       'question_user_page', 'answer', 'answer_user_name', 'answer_user_pag
e',
       'url', 'category', 'host', 'question_asker_intent_understanding',
       'question_body_critical', 'question_conversational',
       'question_expect_short_answer', 'question_fact_seeking',
       'question_has_commonly_accepted_answer',
       'question_interestingness_others', 'question_interestingness_self',
       'question_multi_intent', 'question_not_really_a_question',
       'question_opinion_seeking', 'question_type_choice',
       'question_type_compare', 'question_type_consequence',
       'question_type_definition', 'question_type_entity',
       'question_type_instructions', 'question_type_procedure',
       'question_type_reason_explanation', 'question_type_spelling',
       'question_well_written', 'answer_helpful',
       'answer_level_of_information', 'answer_plausible', 'answer_relevanc
e',
       'answer_satisfaction', 'answer_type_instructions',
       'answer_type_procedure', 'answer_type_reason_explanation',
       'answer_well_written'],
      dtype='object')
```

In [ ]:

```
train_data['question_body_critical'].value_counts
```

Out[9]:

```
<bound method IndexOpsMixin.value_counts of 0       0.333333
1       1.000000
2       0.666667
3       0.666667
4       0.666667
          ...
6074    0.777778
6075    0.777778
6076    0.555556
6077    0.444444
6078    1.000000
Name: question_body_critical, Length: 6079, dtype: float64>
```

In [ ]:

```
targets = list(sample_submission.columns[1:])
print(len(targets))
targets
```

```
30
```

Out[10]:

```
['question_asker_intent_understanding',
 'question_body_critical',
 'question_conversational',
 'question_expect_short_answer',
 'question_fact_seeking',
 'question_has_commonly_accepted_answer',
 'question_interestingness_others',
 'question_interestingness_self',
 'question_multi_intent',
 'question_not_really_a_question',
 'question_opinion_seeking',
 'question_type_choice',
 'question_type_compare',
 'question_type_consequence',
 'question_type_definition',
 'question_type_entity',
 'question_type_instructions',
 'question_type_procedure',
 'question_type_reason_explanation',
 'question_type_spelling',
 'question_well_written',
 'answer_helpful',
 'answer_level_of_information',
 'answer_plausible',
 'answer_relevance',
 'answer_satisfaction',
 'answer_type_instructions',
 'answer_type_procedure',
 'answer_type_reason_explanation',
 'answer_well_written']
```

Statistical overview of the Data

In [ ]:

```
train_data[targets].describe()
```

Out[11]:

	question_asker_intent_understanding	question_body_critical	question_conversational	que
count	6079.000000	6079.000000	6079.000000	
mean	0.892663	0.595301	0.057301	
std	0.132047	0.219470	0.182196	
min	0.333333	0.333333	0.000000	
25%	0.777778	0.444444	0.000000	
50%	0.888889	0.555556	0.000000	
75%	1.000000	0.777778	0.000000	
max	1.000000	1.000000	1.000000	

8 rows × 30 columns

In [ ]:

```
# checking missing data
total = train_data.isnull().sum().sort_values(ascending = False)
percent = (train_data.isnull().sum()/train_data.isnull().count()*100).sort_values(ascending
missing_train_data  = pd.concat([total, percent], axis=1, keys=['Total', 'Percent'])
missing_train_data.head()
```

Out[12]:

	Total	Percent
answer_well_written	0	0.0
question_multi_intent	0	0.0
question_interestingness_others	0	0.0
question_has_commonly_accepted_answer	0	0.0
question_fact_seeking	0	0.0

In [ ]:

```
# checking missing data
total = test_data.isnull().sum().sort_values(ascending = False)
percent = (test_data.isnull().sum()/test_data.isnull().count()*100).sort_values(ascending =
missing_test_data  = pd.concat([total, percent], axis=1, keys=['Total', 'Percent'])
missing_test_data.head()
```

Out[13]:

	Total	Percent
host	0	0.0
category	0	0.0
url	0	0.0
answer_user_page	0	0.0
answer_user_name	0	0.0

- No Missing Values present in Train Data and Test Data

Exploratory Data Analysis

Distribution of Host(from which website Question & Answers collected)

In [ ]:

```
temp = train_data["host"].value_counts()
df = pd.DataFrame({'labels': temp.index,
                   'values': temp.values
                  })
df.iplot(kind='pie',labels='labels',values='values', title='Distribution of hosts in Traini
```

In [ ]:

```
temp = test_data["host"].value_counts()
df = pd.DataFrame({'labels': temp.index,
                   'values': temp.values
                  })
df.iplot(kind='pie',labels='labels',values='values', title='Distribution of hosts in test c
```

Conclusion

- In Training DataSet Stackoverflow.com from which most website Question & Answers collected over 20.6% and 1253 datapoint.
- english.stackexchange.com has contributed 3.77 % and 229 in DataSet.
- In Testing DataSet Stackoverflow.com from which most website Question & Answers collected over 21.6% and 103 datapoint.
- english.stackexchange.com has contributed 4.2 % and 20 in DataSet.

Distribution of categories

In [ ]:

```
temp = train_data["category"].value_counts()
#print("Total number of states : ",len(temp))
trace = go.Bar(
    x = temp.index,
    y = (temp / temp.sum())*100,
)
data = [trace]
layout = go.Layout(
    title = "Distribution of categories in training data in % ",
    xaxis=dict(
        title='category',
        tickfont=dict(
            size=14,
            color='rgb(107, 107, 107)'
        )
    ),
    yaxis=dict(
        title='Count in %',
        titlefont=dict(
            size=16,
            color='rgb(107, 107, 107)'
        ),
        tickfont=dict(
            size=14,
            color='rgb(107, 107, 107)'
        )
)
)
fig = go.Figure(data=data, layout=layout)
py.iplot(fig, filename='test')
```

In [ ]:

```
temp = test_data["category"].value_counts()
#print("Total number of states : ",len(temp))
trace = go.Bar(
    x = temp.index,
    y = (temp / temp.sum())*100,
)
data = [trace]
layout = go.Layout(
    title = "Distribution of categories in test data in % ",
    xaxis=dict(
        title='category',
        tickfont=dict(
            size=14,
            color='rgb(107, 107, 107)'
        )
    ),
    yaxis=dict(
        title='Count in %',
        titlefont=dict(
            size=16,
            color='rgb(107, 107, 107)'
        ),
        tickfont=dict(
            size=14,
            color='rgb(107, 107, 107)'
        )
)
)
fig = go.Figure(data=data, layout=layout)
py.iplot(fig, filename='test')
```

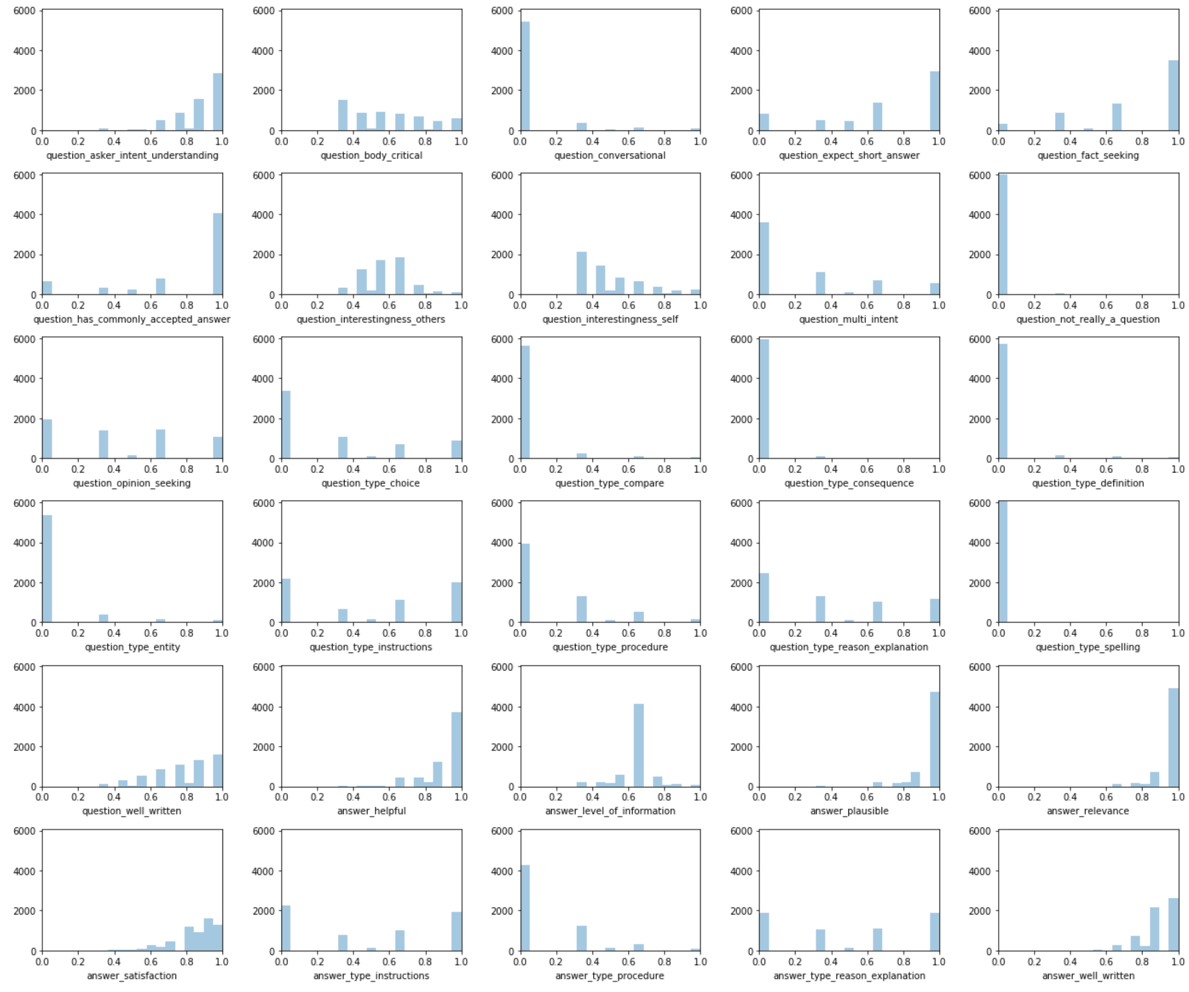
Conclusion Distribution of categories in training data in % and Testting Data

- Distribution of Categories is a Categorical Data conatin Technology,StackoverFlow,Culture , Science and Life arts
- Technology and Stackoverflow has contributed Maximum in training as well as Testing Data set
- Technology = 40% in Training data set and 42.85 % in testing Data set.

Distribution of Target variables

In [ ]:

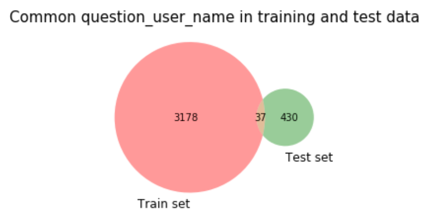
```
fig, axes = plt.subplots(6, 5, figsize=(18, 15))
axes = axes.ravel()
bins = np.linspace(0, 1, 20)

for i, col in enumerate(targets):
    ax = axes[i]
    sns.distplot(train_data[col], label=col, kde=False, bins=bins, ax=ax)
    # ax.set_title(col)
    ax.set_xlim([0, 1])
    ax.set_ylim([0, 6079])
plt.tight_layout()
plt.show()
plt.close()
```

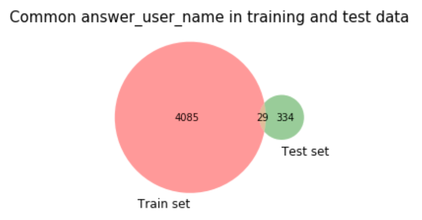


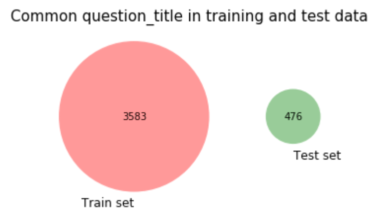
Venn Diagram(Common Features values in training and test data)¶

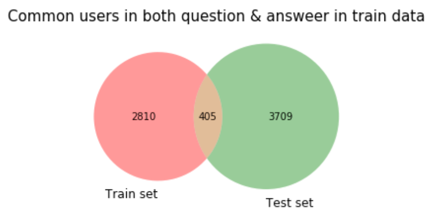
In [ ]:

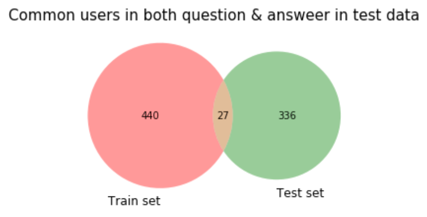
```
plt.figure(figsize=(23,13))

plt.subplot(321)
venn2([set(train_data.question_user_name.unique()), set(test_data.question_user_name.unique
plt.title("Common question_user_name in training and test data", fontsize=15)
#plt.show()

#plt.figure(figsize=(15,8))
plt.subplot(322)
venn2([set(train_data.answer_user_name.unique()), set(test_data.answer_user_name.unique())]
plt.title("Common answer_user_name in training and test data", fontsize=15)
#plt.show()

#plt.figure(figsize=(15,8))
plt.subplot(323)
venn2([set(train_data.question_title.unique()), set(test_data.question_title.unique())], se
plt.title("Common question_title in training and test data", fontsize=15)
#plt.show()

#plt.figure(figsize=(15,8))
plt.subplot(324)
venn2([set(train_data.question_user_name.unique()), set(train_data.answer_user_name.unique(
plt.title("Common users in both question & answeer in train data", fontsize=15)

#plt.figure(figsize=(15,8))
plt.subplot(325)
venn2([set(test_data.question_user_name.unique()), set(test_data.answer_user_name.unique())
plt.title("Common users in both question & answeer in test data", fontsize=15)

plt.subplots_adjust(wspace = 0.5, hspace = 0.5,
                    top = 0.9)
plt.show()
from matplotlib_venn import venn2
```











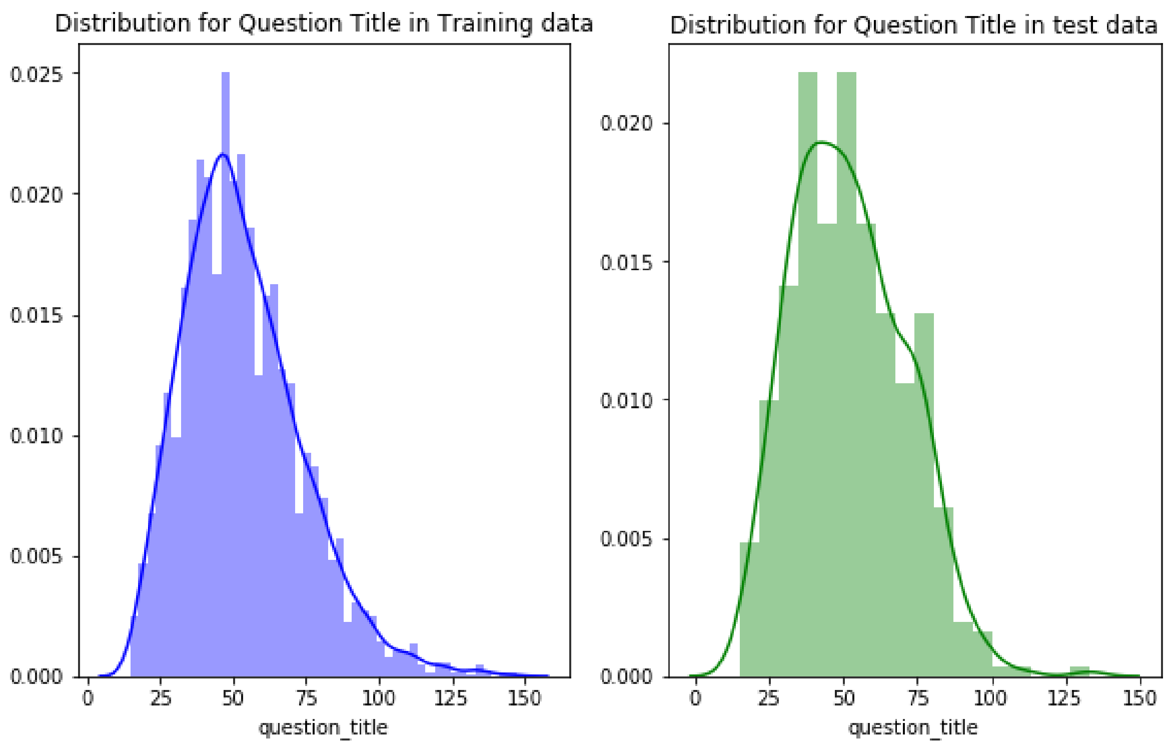
Conclusion

- Above Ven diagram shows that common feature in training and testing Data set
- There no common question_title present in traning and testing dataset.i.e all question title is unique in testing dataset.
- The Most common Feature present in training as well as testing is answer_user_name is 405

Distribution for Question Title

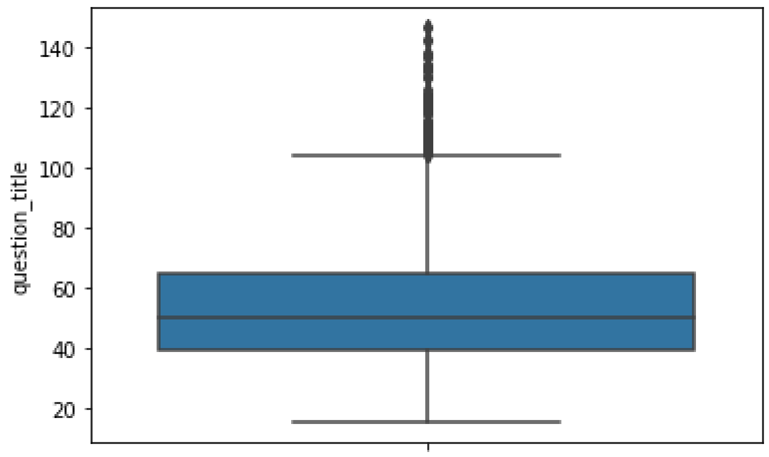
In [ ]:

```
train_question_title=train_data['question_title'].str.len()
test_question_title=test_data['question_title'].str.len()
fig,(ax1,ax2)=plt.subplots(1,2,figsize=(10,6))
sns.distplot(train_question_title,ax=ax1,color='blue')
sns.distplot(test_question_title,ax=ax2,color='green')
ax2.set_title('Distribution for Question Title in test data')
ax1.set_title('Distribution for Question Title in Training data')
plt.show()
```



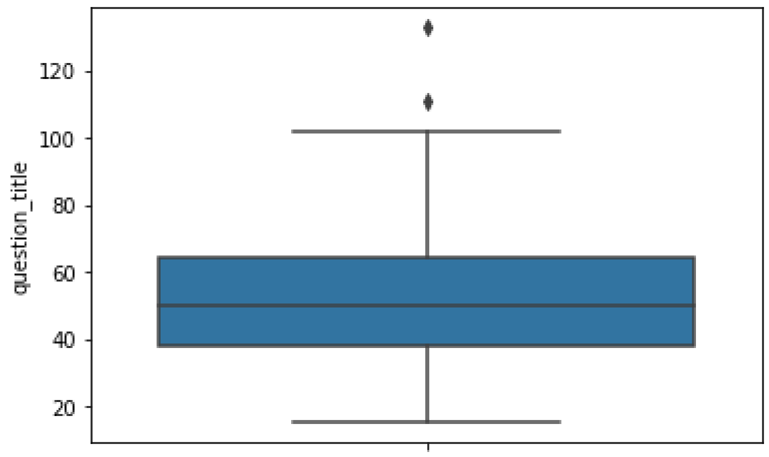
In [ ]:

```
sns.boxplot(y=train_question_title,data=train_data)
plt.show()
```



In [ ]:

```
sns.boxplot(y=test_question_title,data=train_data)
plt.show()
```



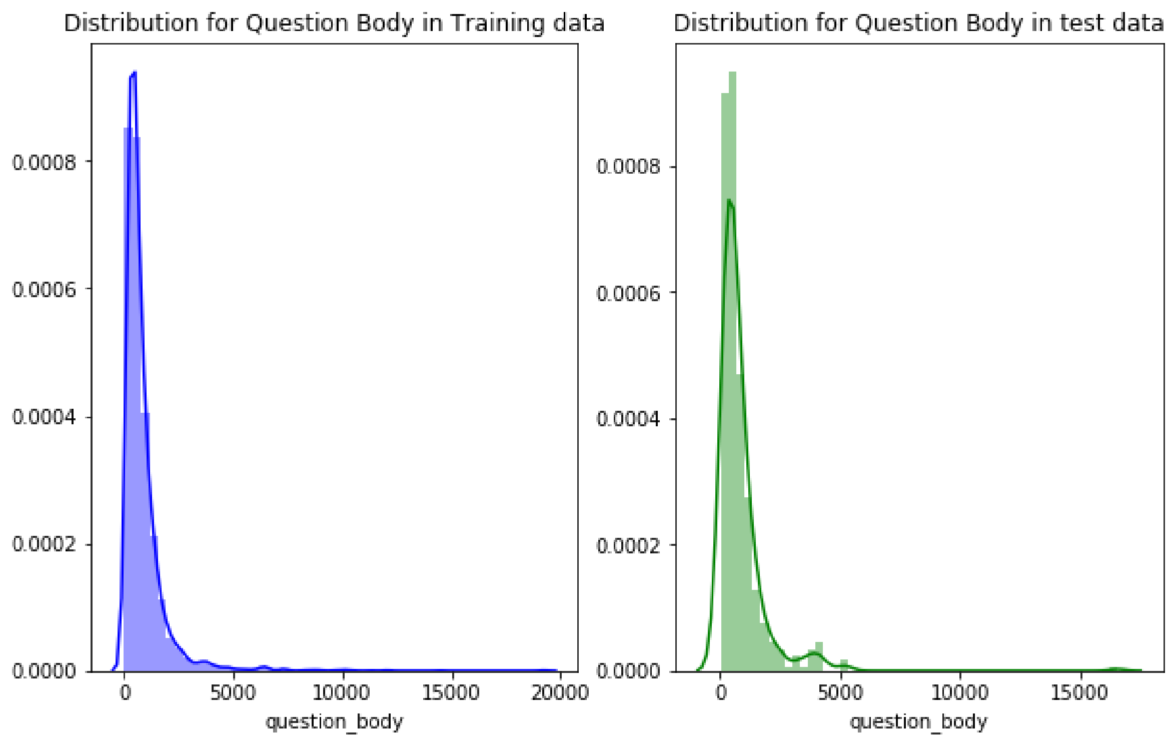
Distribution for Question Title

- Question title having Number of wods lies between 25 to 50 contribtes more in training as well as testing dataset

Distribution for Question body¶

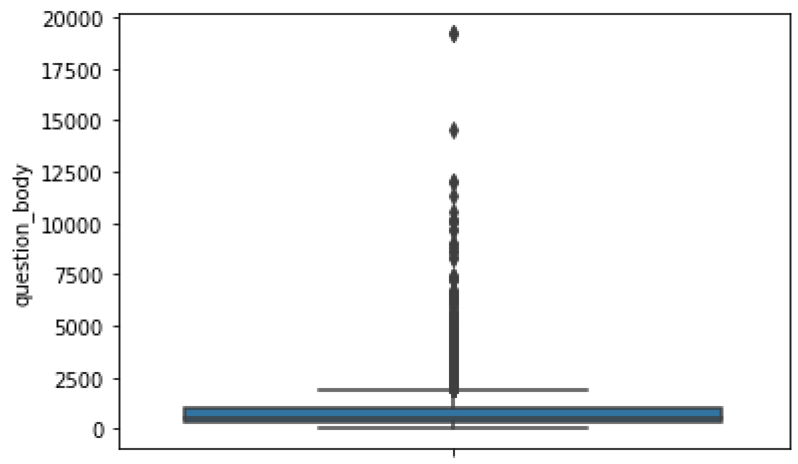
In [ ]:

```
train_question_title=train_data['question_body'].str.len()
test_question_title=test_data['question_body'].str.len()
fig,(ax1,ax2)=plt.subplots(1,2,figsize=(10,6))
sns.distplot(train_question_title,ax=ax1,color='blue')
sns.distplot(test_question_title,ax=ax2,color='green')
ax2.set_title('Distribution for Question Body in test data')
ax1.set_title('Distribution for Question Body in Training data')
plt.show()
```



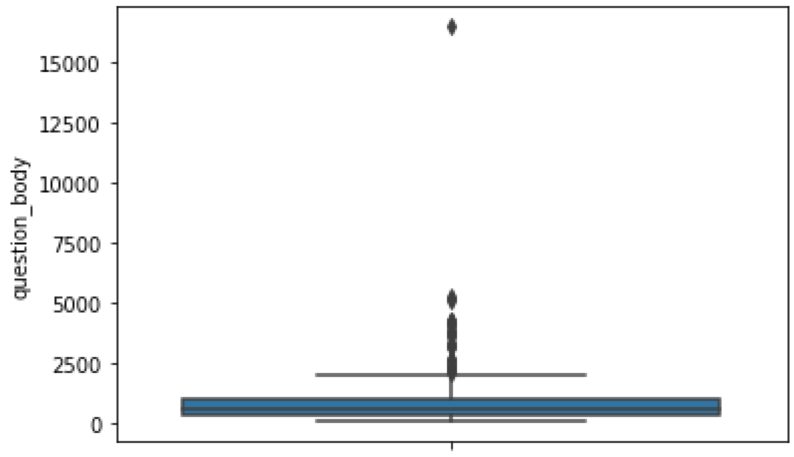
In [ ]:

```
sns.boxplot(y=train_question_title,data=train_data)
plt.show()
```



In [ ]:

```
sns.boxplot(y=test_question_title,data=train_data)
plt.show()
```



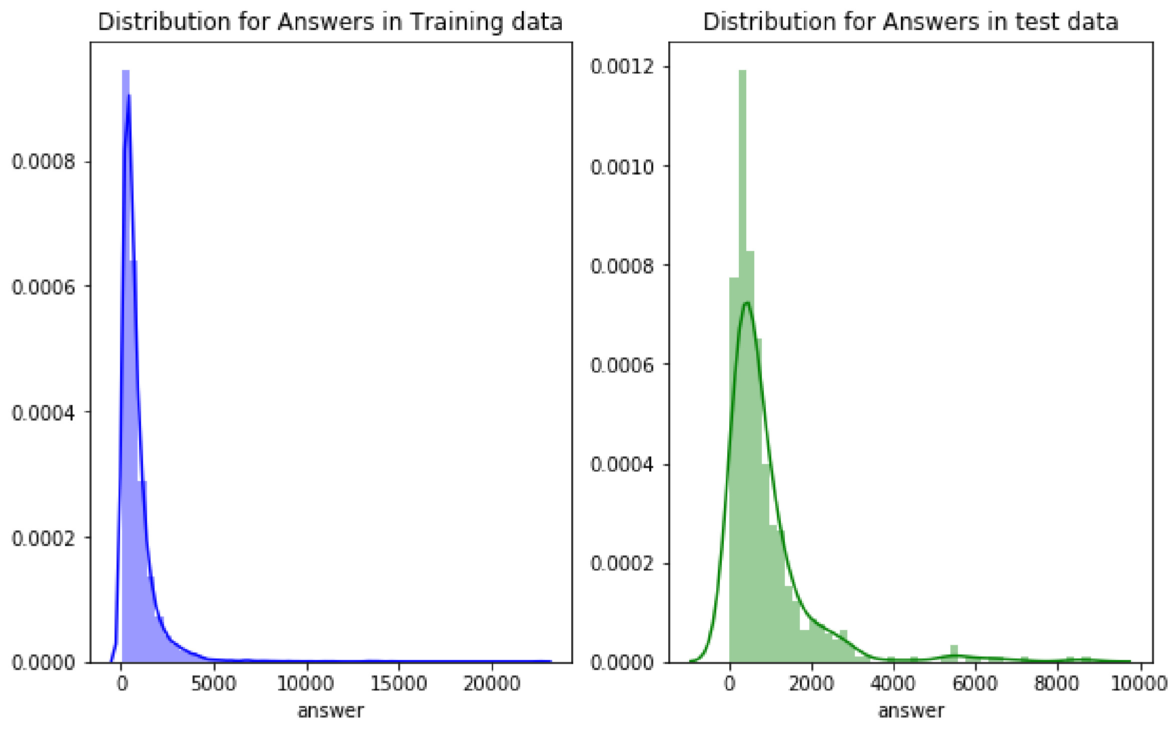
Distribution for Question

- Question Body having Number of wods lies between 300 to 500 contribtes more in training as well as testing dataset

Distribution for Answers

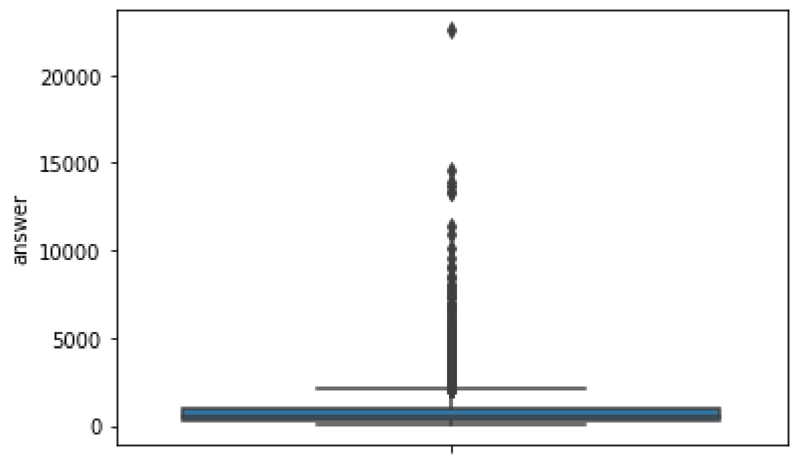
In [ ]:

```
train_question_title=train_data['answer'].str.len()
test_question_title=test_data['answer'].str.len()
fig,(ax1,ax2)=plt.subplots(1,2,figsize=(10,6))
sns.distplot(train_question_title,ax=ax1,color='blue')
sns.distplot(test_question_title,ax=ax2,color='green')
ax2.set_title('Distribution for Answers in test data')
ax1.set_title('Distribution for Answers in Training data')
plt.show()
```



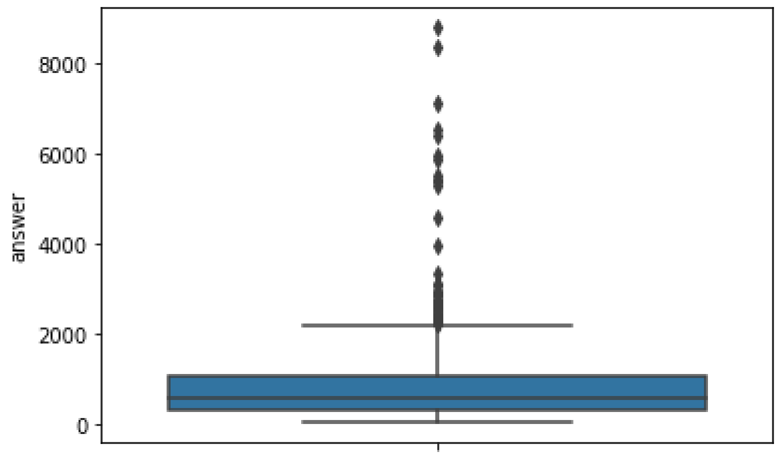
In [ ]:

```
sns.boxplot(y=train_question_title,data=train_data)
plt.show()
```



In [ ]:

```
sns.boxplot(y=test_question_title,data=train_data)
plt.show()
```



Distribution for Question answer

- Question Answer having Number of wods lies between 300 to 500 contribtes more in training as well as testing dataset

Duplicate Questions Title & Most popular Questions

In [ ]:

```
#  Duplicate Questions
print("Number of duplicate questions in descending order")
print("-----------------------------------------------------")
train_data.groupby('question_title').count()['qa_id'].sort_values(ascending=False).head(25)
```

```
Number of duplicate questions in descending order
------------------------------------------------------
```

Out[29]:

```
question_title
What is the best introductory Bayesian statistics textbook?
12
What does mathematics have to do with programming?
11
Important non-technical course for programmers?
11
How to prevent the "Too awesome to use" syndrome
9
Another instructor is pushing me out of the classroom right after my class e
nds      7
No sound in Ubuntu except at log in
7
How do I deal with a slow and undedicated colleague in the team?
7
What are the benefits of owning a physical book?
7
House rules to make the cloister less of a game winning tile in Carcassonne?
6
Making sure that you have comprehended a concept
6
hide javascript/jquery scripts from html page?
6
What is the best place to start Warhammer 40k?
6
Is pretending to want to trade before playing a monopoly card objectionable?
6
Does "so far, so good" carry a negative connotation?
6
Good travel games for two players, especially for playing on trains?
6
Effects of nuclear explosions in space?
6
Is there any performance difference between ++i and i++ in C#?
6
When should a supervisor be a co-author?
6
Isn’t the FAQ label obsolete by now?
6
Should I tell other interviewers where else I've interviewed?
6
CASTING attributes for Ordering on a Doctrine2 DQL Query
5
What is the Goal of "Hot Network Questions"?
5
How to make extra crispy and crunchy breading like KFC?
5
business-class fiber to the home
5
```

```
Why are there so many different types of screws (phillps/flat/hex/star/etc)?
5
Name: qa_id, dtype: int64
```

Most popular questions

In [ ]:

```
train_data[train_data['question_title'] == 'What is the best introductory Bayesian statisti
```

Out[30]:

	qa_id	question_title	question_body	question_user_name	question_user_
229	366	What is the best introductory Bayesian statist...	Which is the best introductory textbook for Ba...	Shane	https://stats.stackexchange.com/us
1616	2536	What is the best introductory Bayesian statist...	Which is the best introductory textbook for Ba...	Shane	https://stats.stackexchange.com/us
1647	2591	What is the best introductory Bayesian statist...	Which is the best introductory textbook for Ba...	Shane	https://stats.stackexchange.com/us
2104	3349	What is the best introductory Bayesian statist...	Which is the best introductory textbook for Ba...	Shane	https://stats.stackexchange.com/us
3476	5543	What is the best introductory Bayesian statist...	Which is the best introductory textbook for Ba...	Shane	https://stats.stackexchange.com/us
3762	5989	What is the best introductory Bayesian statist...	Which is the best introductory textbook for Ba...	Shane	https://stats.stackexchange.com/us
3801	6041	What is the best introductory Bayesian statist...	Which is the best introductory textbook for Ba...	Shane	https://stats.stackexchange.com/us
3899	6215	What is the best introductory Bayesian statist...	Which is the best introductory textbook for Ba...	Shane	https://stats.stackexchange.com/us
4408	7003	What is the best introductory Bayesian statist...	Which is the best introductory textbook for Ba...	Shane	https://stats.stackexchange.com/us
5239	8328	What is the best introductory Bayesian statist...	Which is the best introductory textbook for Ba...	Shane	https://stats.stackexchange.com/us
5587	8867	What is the best introductory Bayesian statist...	Which is the best introductory textbook for Ba...	Shane	https://stats.stackexchange.com/us

	qa_id	question_title	question_body	question_user_name	question_user_
5766	9137	What is the best introductory Bayesian statist...	Which is the best introductory textbook for Ba...	Shane	https://stats.stackexchange.com/us

12 rows × 41 columns

In [ ]:

```
train_data['category'].value_counts().index
```

Out[31]:

```
Index(['TECHNOLOGY', 'STACKOVERFLOW', 'CULTURE', 'SCIENCE', 'LIFE_ARTS'], dt
ype='object')
```

ploting some WordClouds by Categories

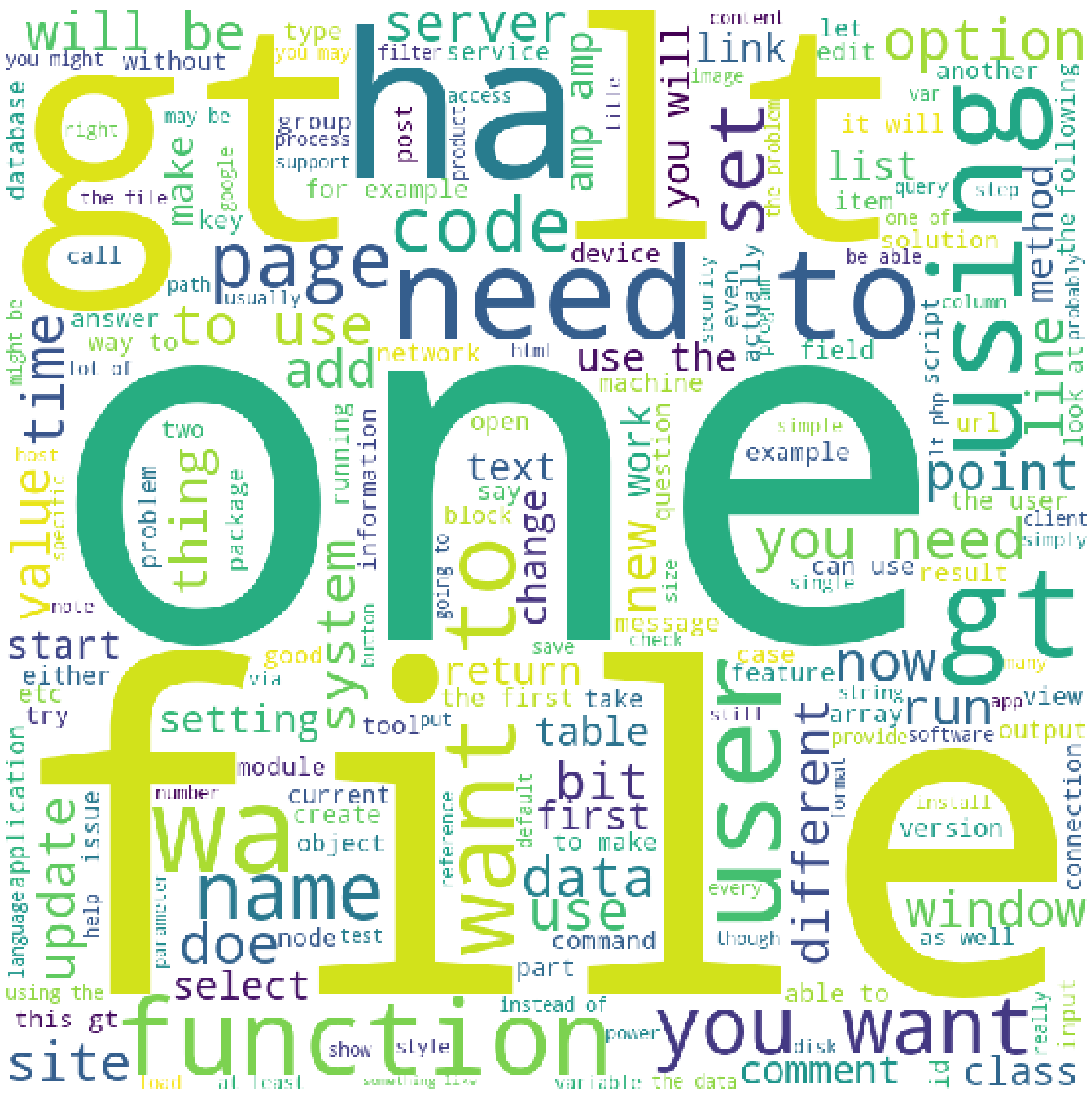
In [ ]:

```
from wordcloud import WordCloud, STOPWORDS
from tqdm import tqdm
comment_words = ' '
stopwords = set(STOPWORDS)
for val in tqdm(train_data[train_data['category'] =='TECHNOLOGY']['answer'].astype(str)):
    val = str(val)

    # split the value
    tokens = val.split()
    for i in range(len(tokens)):
        tokens[i] = tokens[i].lower()
    for words in tokens:
        comment_words = comment_words + words + ' '
```

```
100%|██████████| 2441/2441 [00:53<00:00, 45.88it/s]
```

In [ ]:

```
wordcloud = WordCloud(width = 800, height = 800,
                background_color ='white',
                stopwords = stopwords,
                min_font_size = 10).generate(comment_words)
# plot the WordCloud image
plt.figure(figsize = (8, 8), facecolor = None)
plt.imshow(wordcloud)
plt.axis("off")
plt.tight_layout(pad = 0)

plt.show()
```



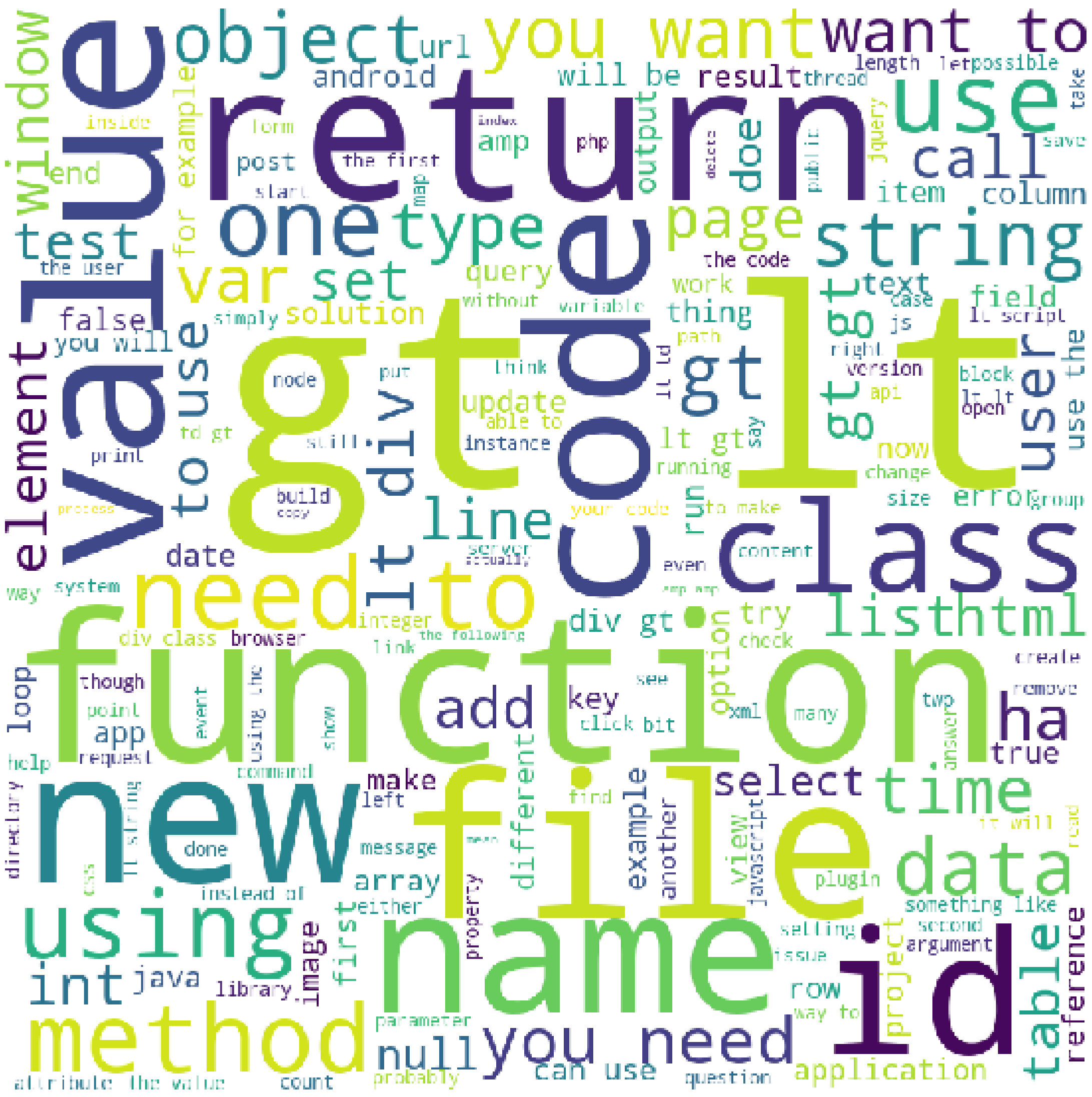
In [ ]:

```
from wordcloud import WordCloud, STOPWORDS
from tqdm import tqdm
comment_words = ' '
stopwords = set(STOPWORDS)
for val in tqdm(train_data[train_data['category'] =='STACKOVERFLOW']['answer'].astype(str))
    val = str(val)

    # split the value
    tokens = val.split()
    for i in range(len(tokens)):
        tokens[i] = tokens[i].lower()
    for words in tokens:
        comment_words = comment_words + words + ' '
```

```
100%|██████████| 1253/1253 [00:06<00:00, 184.03it/s]
```

In [ ]:

```
wordcloud = WordCloud(width = 800, height = 800,
                background_color ='white',
                stopwords = stopwords,
                min_font_size = 10).generate(comment_words)
# plot the WordCloud image
plt.figure(figsize = (8, 8), facecolor = None)
plt.imshow(wordcloud)
plt.axis("off")
plt.tight_layout(pad = 0)

plt.show()
```



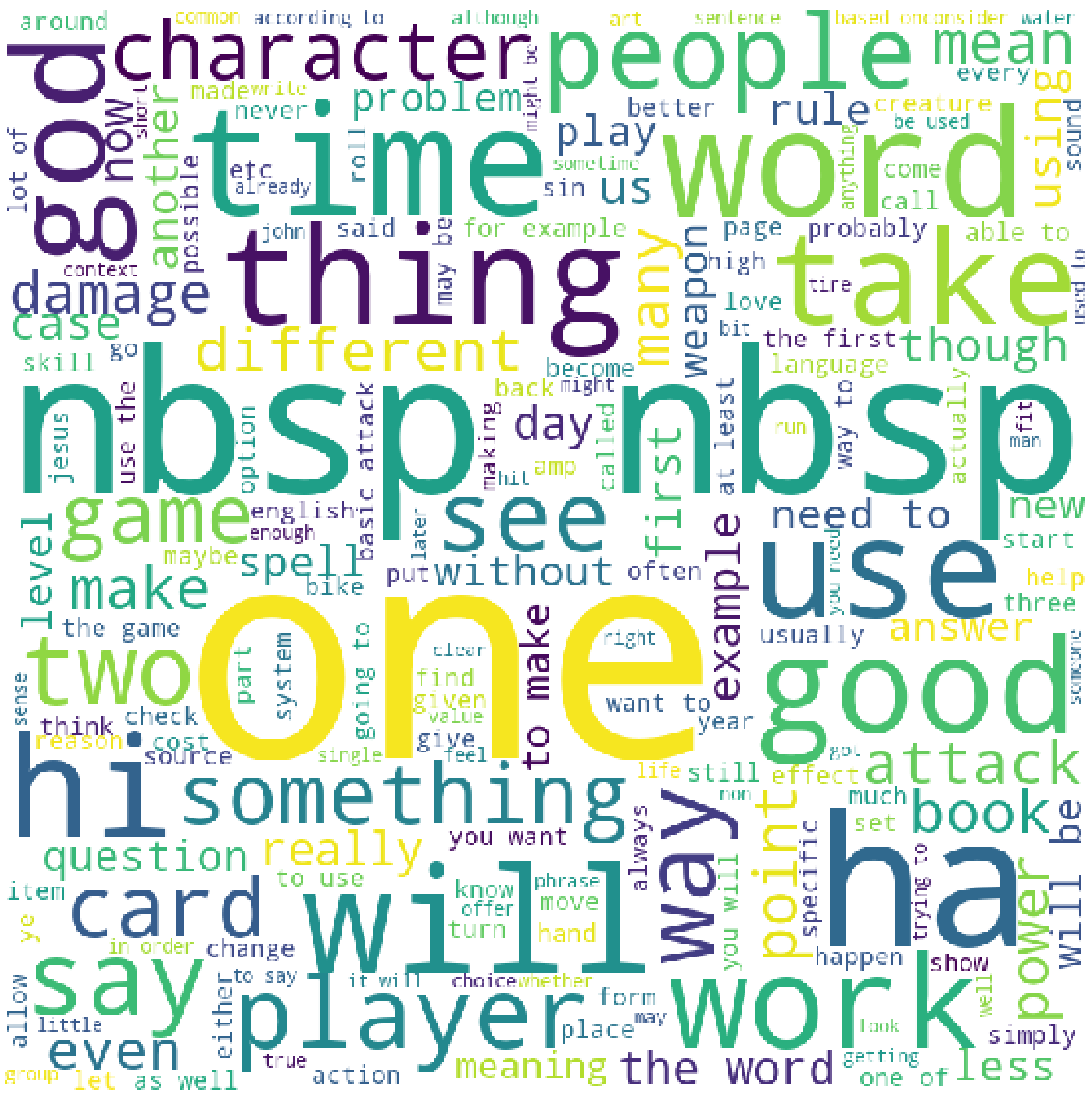
In [ ]:

```
from wordcloud import WordCloud, STOPWORDS
from tqdm import tqdm
comment_words = ' '
stopwords = set(STOPWORDS)
for val in tqdm(train_data[train_data['category'] =='CULTURE']['answer'].astype(str)):
    val = str(val)

    # split the value
    tokens = val.split()
    for i in range(len(tokens)):
        tokens[i] = tokens[i].lower()
    for words in tokens:
        comment_words = comment_words + words + ' '
```

```
100%|██████████| 963/963 [00:10<00:00, 91.76it/s]
```

In [ ]:

```
wordcloud = WordCloud(width = 800, height = 800,
                background_color ='white',
                stopwords = stopwords,
                min_font_size = 10).generate(comment_words)
# plot the WordCloud image
plt.figure(figsize = (8, 8), facecolor = None)
plt.imshow(wordcloud)
plt.axis("off")
plt.tight_layout(pad = 0)

plt.show()
```



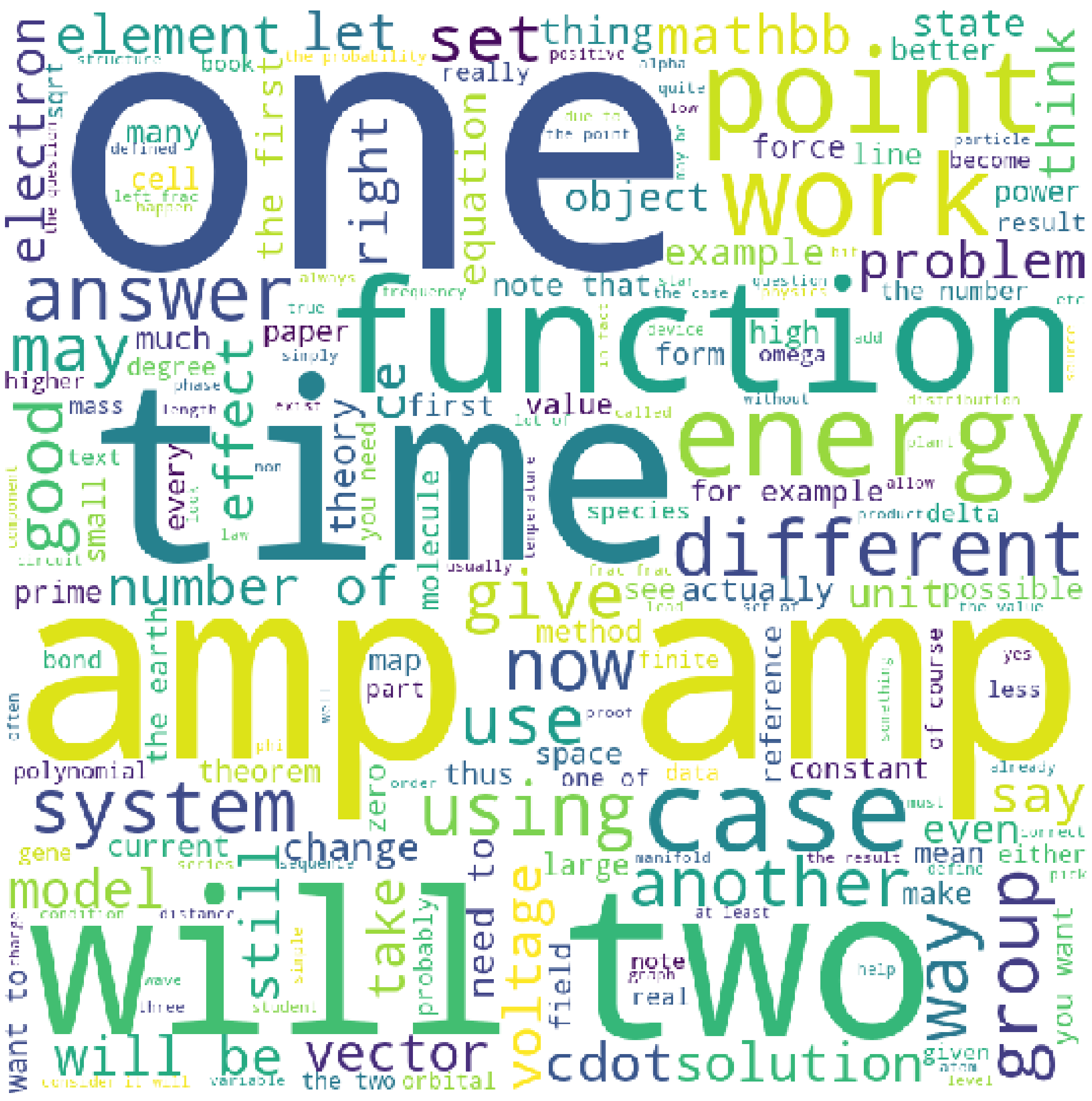
```
In [ ]:
```

```python
from wordcloud import WordCloud, STOPWORDS
from tqdm import tqdm
comment_words = ' '
stopwords = set(STOPWORDS)
for val in tqdm(train_data[train_data['category'] =='SCIENCE']['answer'].astype(str)):
    val = str(val)

    # split the value
    tokens = val.split()
    for i in range(len(tokens)):
        tokens[i] = tokens[i].lower()
    for words in tokens:
        comment_words = comment_words + words + ' '
```

```
100%|██████████| 713/713 [00:06<00:00, 112.85it/s]
```

In [ ]:

```python
wordcloud = WordCloud(width = 800, height = 800,
                background_color ='white',
                stopwords = stopwords,
                min_font_size = 10).generate(comment_words)
# plot the WordCloud image
plt.figure(figsize = (8, 8), facecolor = None)
plt.imshow(wordcloud)
plt.axis("off")
plt.tight_layout(pad = 0)

plt.show()
```



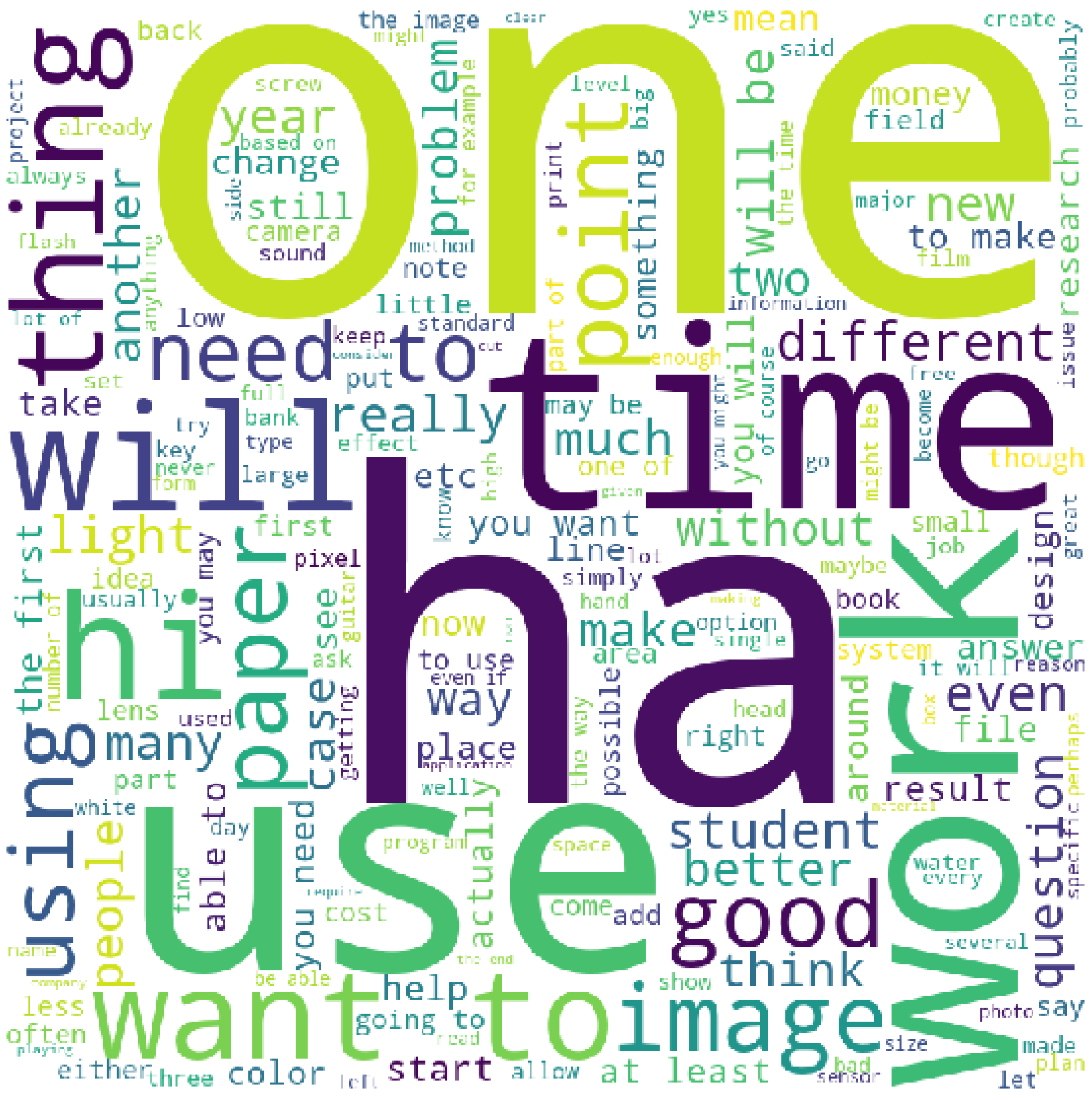
In [ ]:

```
from wordcloud import WordCloud, STOPWORDS
from tqdm import tqdm
comment_words = ' '
stopwords = set(STOPWORDS)
for val in tqdm(train_data[train_data['category'] =='LIFE_ARTS']['answer'].astype(str)):
    val = str(val)

    # split the value
    tokens = val.split()
    for i in range(len(tokens)):
        tokens[i] = tokens[i].lower()
    for words in tokens:
        comment_words = comment_words + words + ' '
```

```
100%|██████████| 709/709 [00:06<00:00, 102.98it/s]
```

In [ ]:

```
wordcloud = WordCloud(width = 800, height = 800,
                background_color ='white',
                stopwords = stopwords,
                min_font_size = 10).generate(comment_words)
# plot the WordCloud image
plt.figure(figsize = (8, 8), facecolor = None)
plt.imshow(wordcloud)
plt.axis("off")
plt.tight_layout(pad = 0)

plt.show()
```



In [ ]:

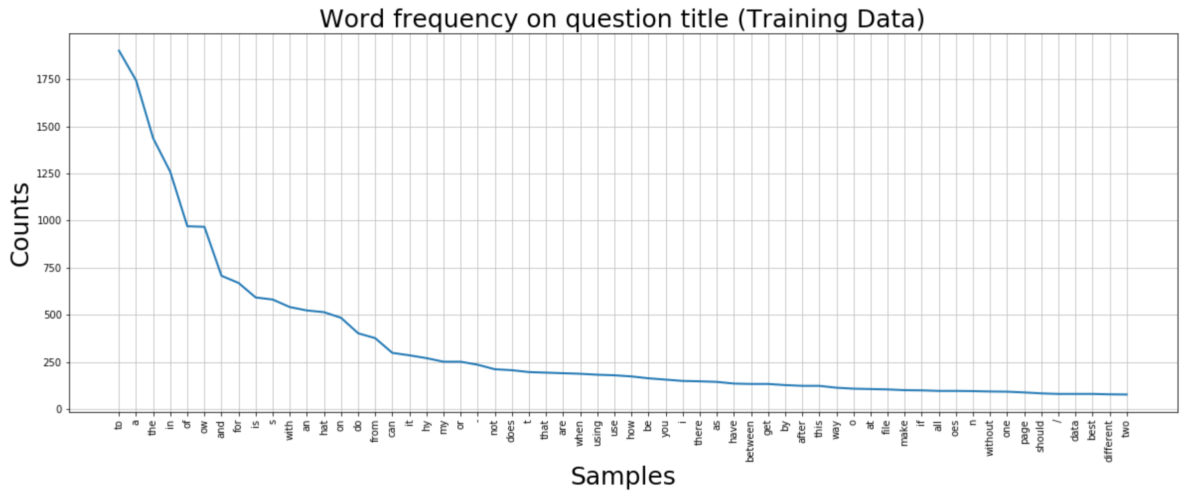
```
# print("Data cleaning started........")
# puncts = [',', '.', '"', ':', ')', '(', '-', '!', '?', '|', ';', "'", '$', '&', '/', '[',
#  '•', '_', '{', '}', '©', '^', '®', '`', '<', '→', '°', '€', '™', '›', '♥', '←', '×', '
#  '“', '★', '”', '–', '●', 'â', '►', '−', '¢', '²', '¬', '░', '¶', '↑', '±', '¿', '▾', '=
#  '▒', '：', '¼', '⊕', '▼', '▪', '†', '■', '’', '▀', '¨', '▄', '♫', '☆', 'é', '¯', '♦',
#  '·', '）', '↓', '、', '│', '（', '»', '，', '♪', '╩', '╚', '³', '・', '╦', '╣', '╔', '╗',
# mispell_dict = {"aren't" : "are not",
# "can't" : "cannot",
# "couldn't" : "could not",
# "couldnt" : "could not",
# "didn't" : "did not",
# "doesn't" : "does not",
# "doesnt" : "does not",
# "don't" : "do not",
# "hadn't" : "had not",
# "hasn't" : "has not",
# "haven't" : "have not",
# "havent" : "have not",
# "he'd" : "he would",
# "he'll" : "he will",
# "he's" : "he is",
# "i'd" : "I would",
# "i'd" : "I had",
# "i'll" : "I will",
# "i'm" : "I am",
# "isn't" : "is not",
# "it's" : "it is",
# "it'll":"it will",
# "i've" : "I have",
# "let's" : "let us",
# "mightn't" : "might not",
# "mustn't" : "must not",
# "shan't" : "shall not",
# "she'd" : "she would",
# "she'll" : "she will",
# "she's" : "she is",
# "shouldn't" : "should not",
# "shouldnt" : "should not",
# "that's" : "that is",
# "thats" : "that is",
# "there's" : "there is",
# "theres" : "there is",
# "they'd" : "they would",
# "they'll" : "they will",
# "they're" : "they are",
# "theyre":  "they are",
# "they've" : "they have",
# "we'd" : "we would",
# "we're" : "we are",
# "weren't" : "were not",
# "we've" : "we have",
# "what'll" : "what will",
# "what're" : "what are",
# "what's" : "what is",
# "what've" : "what have",
# "where's" : "where is",
# "who'd" : "who would",
# "who'll" : "who will",
# "who're" : "who are",
# "who's" : "who is",
# "who've" : "who have",
# "won't" : "will not",
# "wouldn't" : "would not",
# "you'd" : "you would",
# "you'll" : "you will",
# "you're" : "you are",
# "you've" : "you have",
# "'re": " are",
# "wasn't": "was not",
# "we'll":" will",
# "didn't": "did not",
# "tryin'":"trying"}


# def clean_text(text):
#     text = re.sub(r"[^A-Za-z0-9^,!.\/'+-=]", " ", text)
#     text = text.lower().split()
#     stopwords = set(STOPWORDS)
# #     stops = set(stopwords.words("english"))
#     text = [w for w in text if not w in stopwords]
#     text = " ".join(text)
#     return(text)

# def _get_mispell(mispell_dict):
#     mispell_re = re.compile('(%s)' % '|'.join(mispell_dict.keys()))
#     return mispell_dict, mispell_re

# def replace_typical_misspell(text):
#     mispellings, mispellings_re = _get_mispell(mispell_dict)

#     def replace(match):
#         return mispellings[match.group(0)]

#     return mispellings_re.sub(replace, text)

# def clean_data(df, columns: list):
#     for col in columns:
#         df[col] = df[col].apply(lambda x: clean_text(x.lower()))
#         df[col] = df[col].apply(lambda x: replace_typical_misspell(x))

#     return df
```

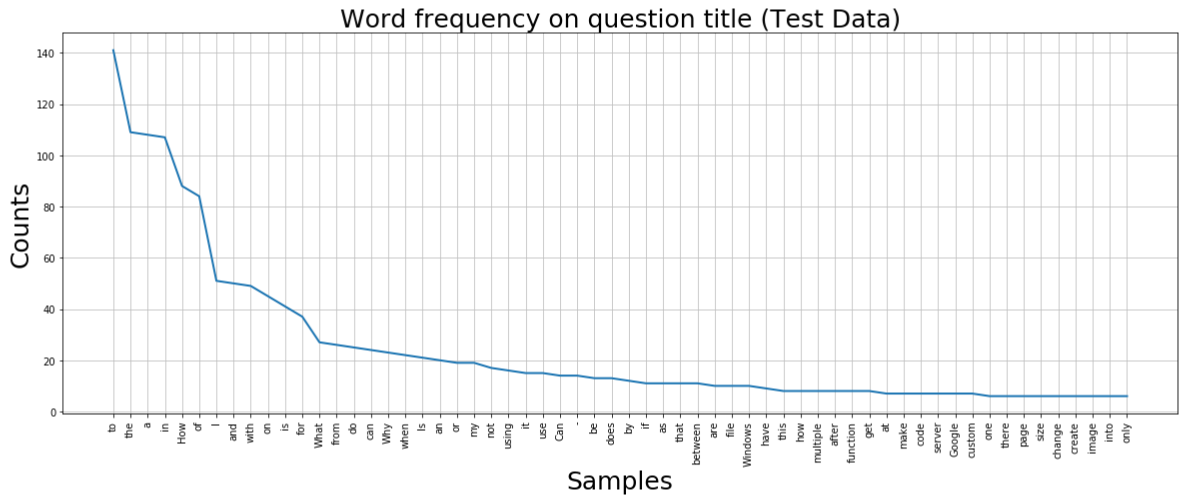
In [ ]:

```
# columns = ['question_title','question_body','answer']
# train_data = clean_data(train_data, columns)
# test_data = clean_data(test_data, columns)
# print("Data cleaning Done........")
```

In [ ]:

```
#  training data
freq_dist = FreqDist([word for text in train_data['question_title'].str.replace('[^a-za-z0-
plt.figure(figsize=(20, 7))
plt.title('Word frequency on question title (Training Data)').set_fontsize(25)
plt.xlabel('').set_fontsize(25)
plt.ylabel('').set_fontsize(25)
freq_dist.plot(60,cumulative=False)
plt.show()

# test data
freq_dist = FreqDist([word for text in test_data['question_title'] for word in text.split()
plt.figure(figsize=(20, 7))
plt.title('Word frequency on question title (Test Data)').set_fontsize(25)
plt.xlabel('').set_fontsize(25)
plt.ylabel('').set_fontsize(25)
freq_dist.plot(60,cumulative=False)
plt.show()
```



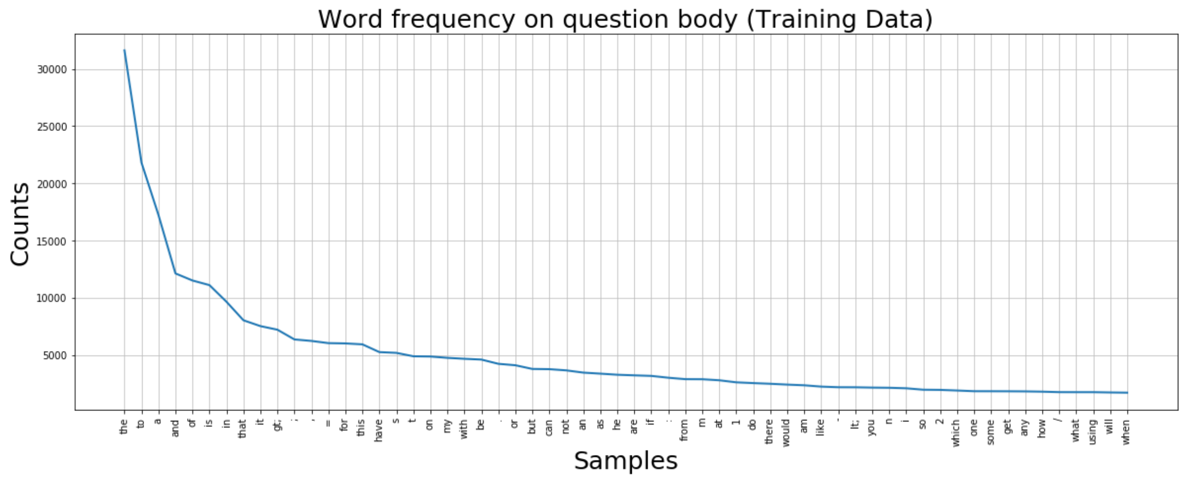


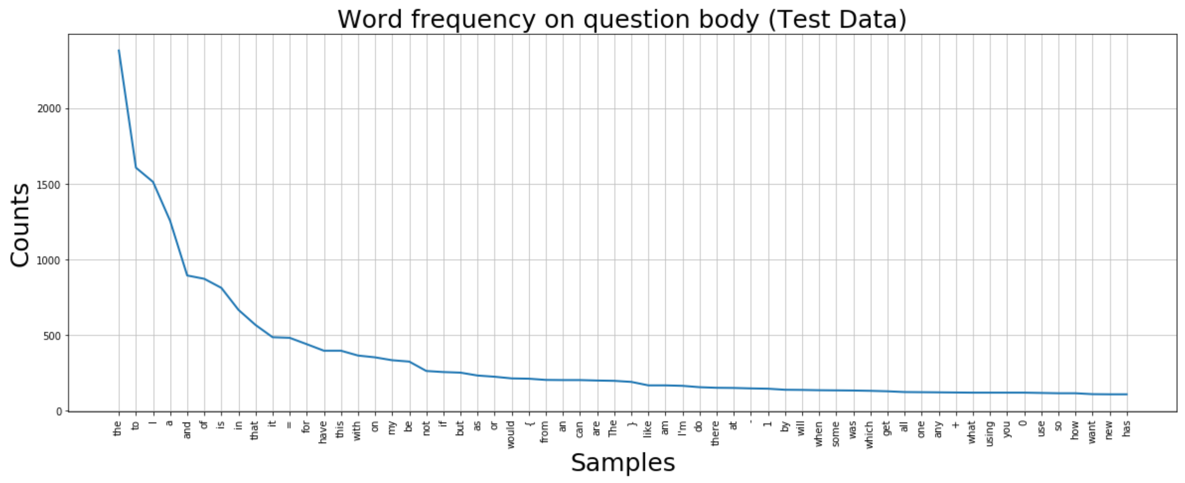
Conclusion

- Word 'using' having maximum Number of Occurence in train as well as test data
- Use ,-, files word also occur in train as well as in test data with almost same Frequency.
- The First three word in train as well as in test Data is same after word frequecy start changing.

In [ ]:

```
# training data
freq_dist = FreqDist([word for text in train_data['question_body'].str.replace('[^a-za-z0-9
plt.figure(figsize=(20, 7))
plt.title('Word frequency on question body (Training Data)').set_fontsize(25)
plt.xlabel('').set_fontsize(25)
plt.ylabel('').set_fontsize(25)
freq_dist.plot(60,cumulative=False)
plt.show()

# test data
freq_dist = FreqDist([word for text in test_data['question_body'] for word in text.split()]
plt.figure(figsize=(20, 7))
plt.title('Word frequency on question body (Test Data)').set_fontsize(25)
plt.xlabel('').set_fontsize(25)
plt.ylabel('').set_fontsize(25)
freq_dist.plot(60,cumulative=False)
plt.show()
```



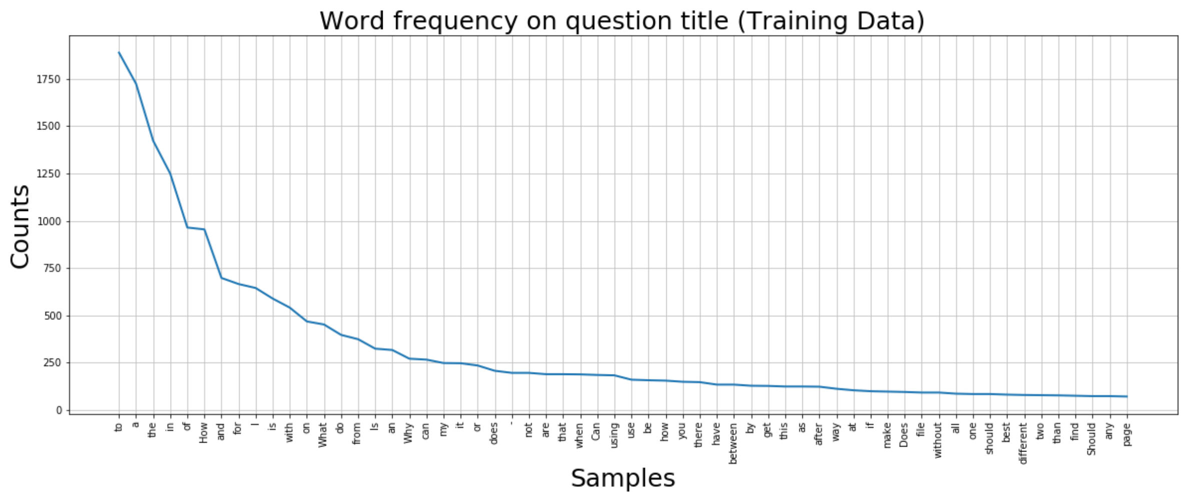


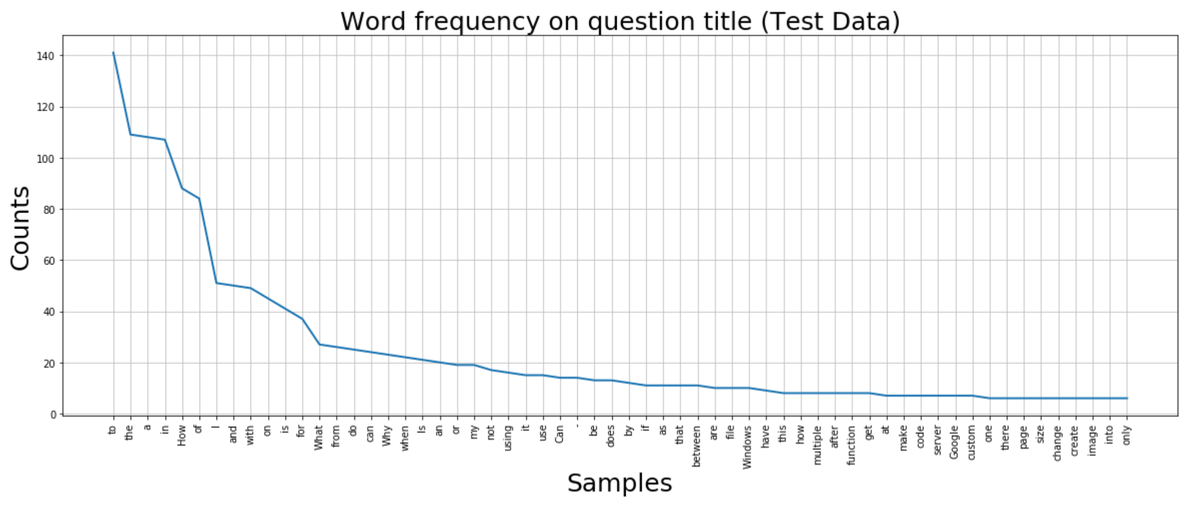
Conclusion

- semicolon having maximum Number of Occurence in train as well as test data
- ';' ,'=', '"' also occur in train as well as in test data with almost same Frequency.
- The First three word in train as well as in test Data is same after word frequecy start changing.

In [ ]:

```
# training data
freq_dist = FreqDist([word for text in train_data['question_title'] for word in text.split(
plt.figure(figsize=(20, 7))
plt.title('Word frequency on question title (Training Data)').set_fontsize(25)
plt.xlabel('').set_fontsize(25)
plt.ylabel('').set_fontsize(25)
freq_dist.plot(60,cumulative=False)
plt.show()

# test data
freq_dist = FreqDist([word for text in test_data['question_title'] for word in text.split()
plt.figure(figsize=(20, 7))
plt.title('Word frequency on question title (Test Data)').set_fontsize(25)
plt.xlabel('').set_fontsize(25)
plt.ylabel('').set_fontsize(25)
freq_dist.plot(60,cumulative=False)
plt.show()
```





Conclusion

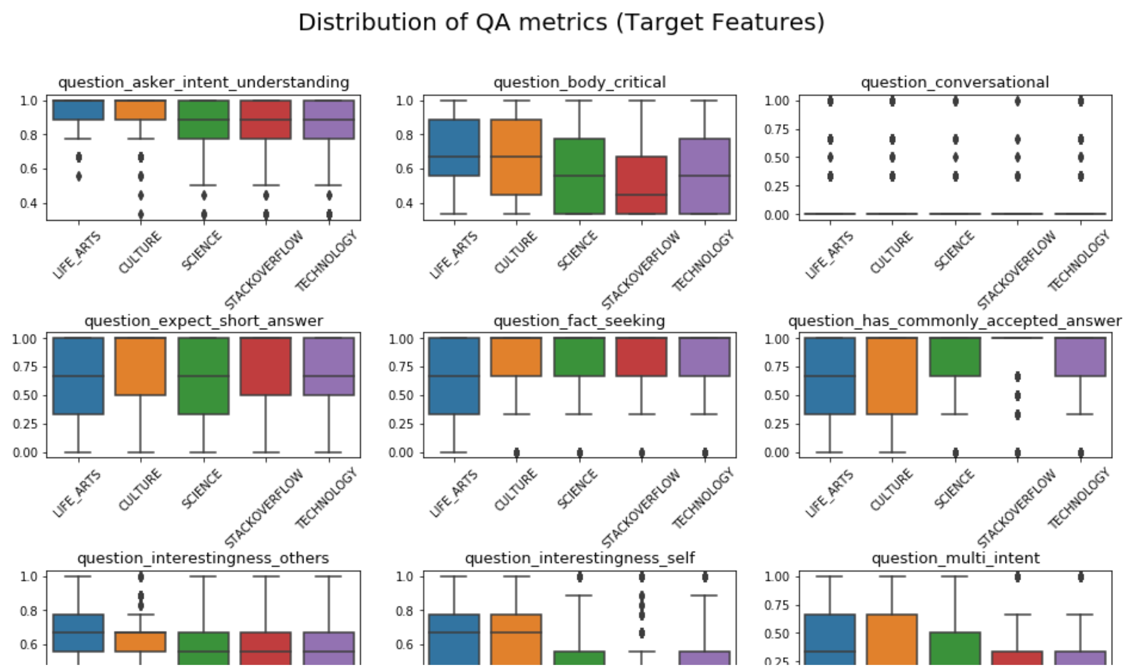
- 'using' having maximum Number of Occurence in train as well as test data
- 'using' ,'use', '- also occur in train as well as in test data with almost same Frequency.
- The First three word in train as well as in test Data is same after word frequecy start changing.

Exploring Target Features

Distribution of all Target Features

In [ ]:

```
grid = gridspec.GridSpec(10, 3)
target_columns = list(sample_submission.columns)[1:]

plt.figure(figsize=(16,8*4))
count=0
plt.suptitle('Distribution of QA metrics (Target Features)', size=20)
# top_host = df_train['host_cat'].value_counts()[:15].index
for n, col in enumerate(target_columns):
    ax = plt.subplot(grid[count])
    sns.boxplot(x='category', y=col, data=train_data)
    ax.set_title(str(col), fontsize=13)
    ax.set_xlabel('')
    ax.set_ylabel(' ')
    count+=1
    ax.set_xticklabels(ax.get_xticklabels(),rotation=45)

plt.subplots_adjust(top = 0.95, hspace=.9, wspace=.2)

plt.show()
```



Conslusion Distribution of all Target Features vs Category

- The above plot a informative chart where we can get the difference between the categories to each target feature.
- question body critical" has an interesting distribution between the different categories has lot of variation.
- question_asker_intent_understanding doesn't show lot varition vs catrgory all 25-75 percentile is same only.
- From the Box Plot question body critical show lot of varition against category

- Target Variable question_not_really_question show lot of varition against category.
- Rest all variable does not have very much variance.

In [ ]:

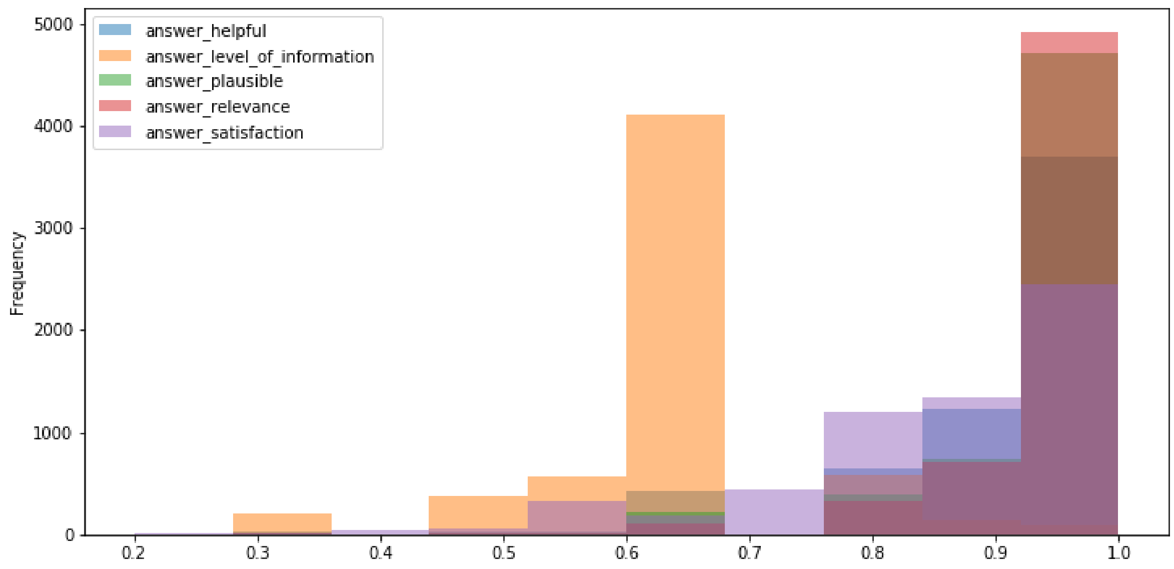
```
import re
question_related_target_cols = [ col for col in target_columns if re.search('^question_', c
answer_related_target_cols = [ col for col in target_columns if re.search('^answer_', col)]
```

In [ ]:

```
train_data[answer_related_target_cols[:5]].plot(kind='hist', figsize=(12, 6), alpha=0.5)
```

Out[49]:

```
<matplotlib.axes._subplots.AxesSubplot at 0x7f707e611588>
```

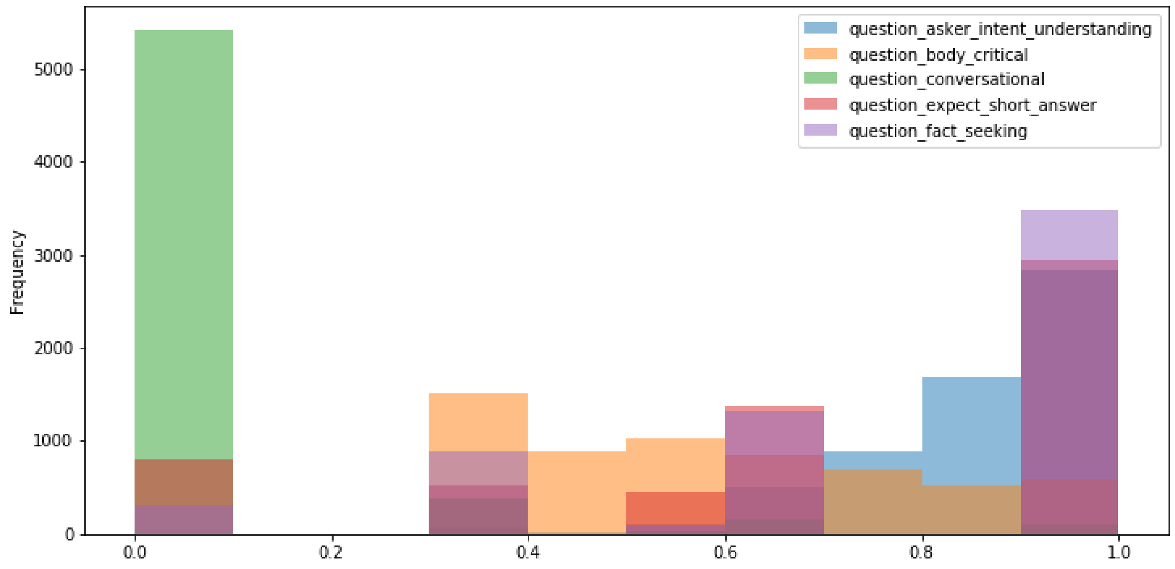


In [ ]:

```
train_data[question_related_target_cols[:5]].plot(kind='hist', figsize=(12, 6), alpha=0.5)
```

Out[50]:

```
<matplotlib.axes._subplots.AxesSubplot at 0x7f70792927f0>
```



Conclusion Frequency vs Question Related Column , Answer Related Column

- From the above Histogram we can conclude that Frequency answer related target has value grater than 0.5
- From the above Histogram we can conclude that Frequency question related target has value grater of 0 ad second largest is 1.

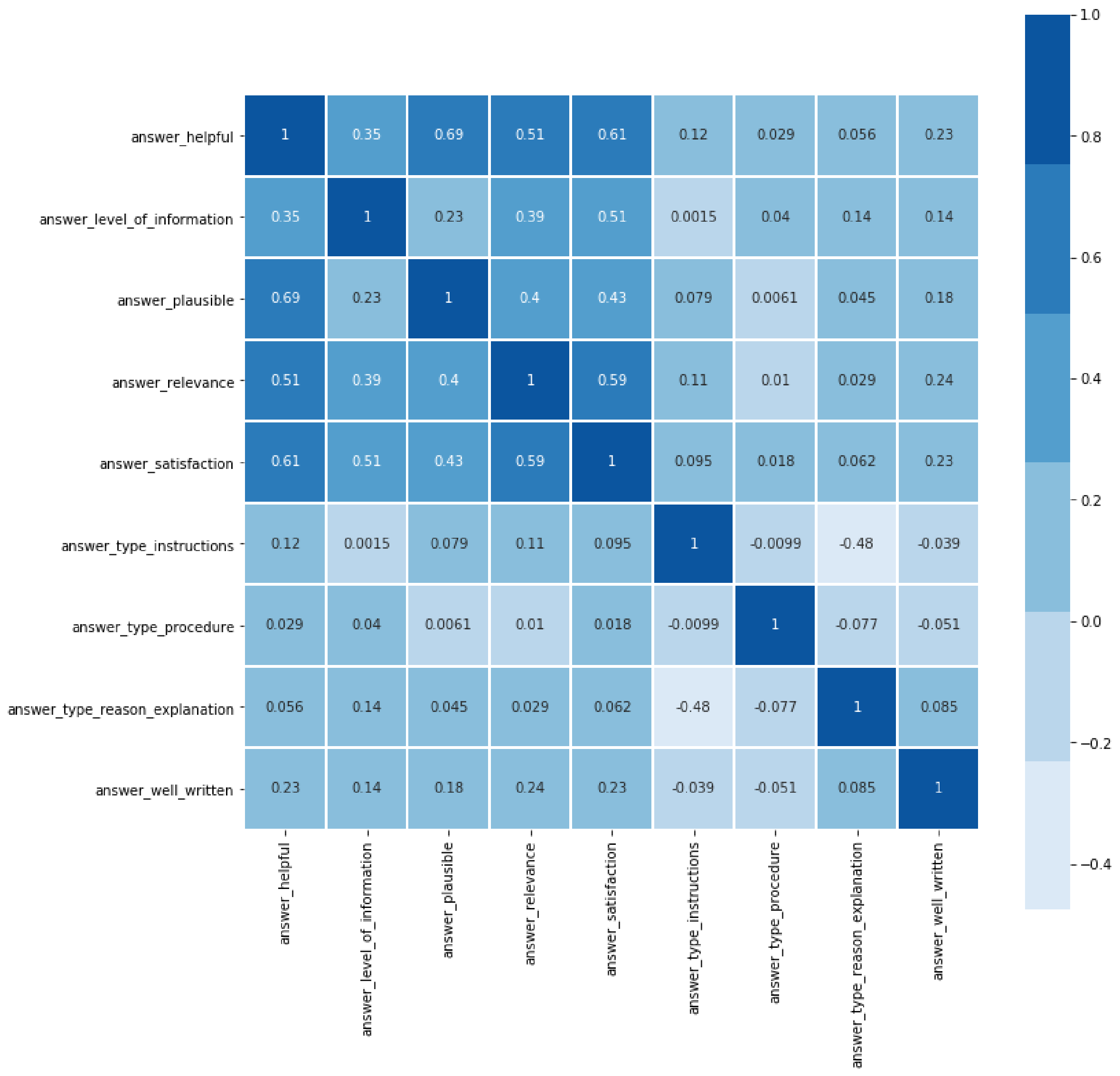
Variable Correlations

In [ ]:

```
plt.figure(figsize=(12, 12))
sns.heatmap(data=train_data[answer_related_target_cols].corr(),
            square=True,
            annot=True,
            linewidths=1,
            cmap=sns.color_palette("Blues"))
```

Out[51]:

```
<matplotlib.axes._subplots.AxesSubplot at 0x7f70790a8048>
```



	answer_helpful	answer_level_of_information	answer_plausible	answer_relevance	answer_satisfaction	answer_type_instructions	answer_type_procedure	answer_type_reason_explanation	answer_well_written
answer_helpful	1	0.35	0.69	0.51	0.61	0.12	0.029	0.056	0.23
answer_level_of_information	0.35	1	0.23	0.39	0.51	0.0015	0.04	0.14	0.14
answer_plausible	0.69	0.23	1	0.4	0.43	0.079	0.0061	0.045	0.18
answer_relevance	0.51	0.39	0.4	1	0.59	0.11	0.01	0.029	0.24
answer_satisfaction	0.61	0.51	0.43	0.59	1	0.095	0.018	0.062	0.23
answer_type_instructions	0.12	0.0015	0.079	0.11	0.095	1	-0.0099	-0.48	-0.039
answer_type_procedure	0.029	0.04	0.0061	0.01	0.018	-0.0099	1	-0.077	-0.051
answer_type_reason_explanation	0.056	0.14	0.045	0.029	0.062	-0.48	-0.077	1	0.085
answer_well_written	0.23	0.14	0.18	0.24	0.23	-0.039	-0.051	0.085	1

Conclusion Variable Correlations

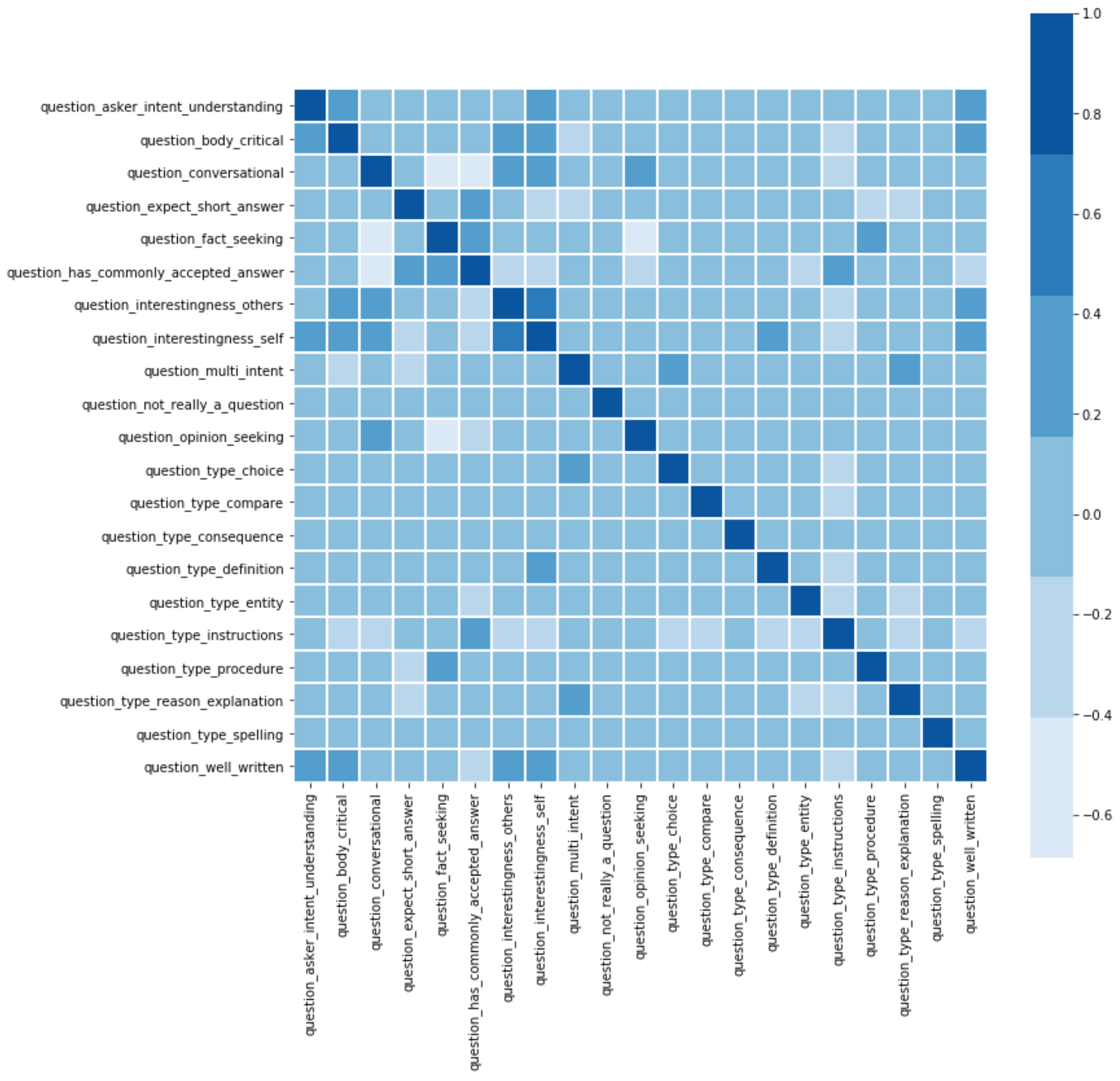
- The above variable correlation heat map answer_related_target_cols describe how answer related the feature related with each other
- As Answer plausable and answer helpfull is very Related with Each other.

In [ ]:

```
plt.figure(figsize=(12, 12))
sns.heatmap(data=train_data[question_related_target_cols].corr(),
            square=True,
            linewidths=1,
            cmap=sns.color_palette("Blues"))
```

Out[52]:

```
<matplotlib.axes._subplots.AxesSubplot at 0x7f7079768f98>
```



Conclusion Variable Correlations

- The above variable correlation heat map question_related_target_cols describe how question related the feature related with each other
- As question instrestingness self and question instrestingness other is very Related with Each other.

Feature Engineering

- Number of characters in the question_title
- Number of characters in the question_body
- Number of characters in the answer
- Number of words in the question_title
- Number of words in the question_body
- Number of words in the answer
- Number of unique words in the question_title
- Number of unique words in the question_body
- Number of unique words in the answer

In [ ]:

```
# Number of characters in the text
train_data["question_title_num_chars"] = train_data["question_title"].apply(lambda x: len(s
train_data["question_body_num_chars"] = train_data["question_body"].apply(lambda x: len(str
train_data["answer_num_chars"] = train_data["answer"].apply(lambda x: len(str(x)))

test_data["question_title_num_chars"] = test_data["question_title"].apply(lambda x: len(str
test_data["question_body_num_chars"] = test_data["question_body"].apply(lambda x: len(str(x
test_data["answer_num_chars"] = test_data["answer"].apply(lambda x: len(str(x)))

# Number of words in the text
train_data["question_title_num_words"] = train_data["question_title"].apply(lambda x: len(s
train_data["question_body_num_words"] = train_data["question_body"].apply(lambda x: len(str
train_data["answer_num_words"] = train_data["answer"].apply(lambda x: len(str(x).split()))

test_data["question_title_num_words"] = test_data["question_title"].apply(lambda x: len(str
test_data["question_body_num_words"] = test_data["question_body"].apply(lambda x: len(str(x
test_data["answer_num_words"] = test_data["answer"].apply(lambda x: len(str(x).split()))

# Number of unique words in the text
train_data["question_title_num_unique_words"] = train_data["question_title"].apply(lambda x
train_data["question_body_num_unique_words"] = train_data["question_body"].apply(lambda x:
train_data["answer_num_unique_words"] = train_data["answer"].apply(lambda x: len(set(str(x)

test_data["question_title_num_unique_words"] = test_data["question_title"].apply(lambda x:
test_data["question_body_num_unique_words"] = test_data["question_body"].apply(lambda x: le
test_data["answer_num_unique_words"] = test_data["answer"].apply(lambda x: len(set(str(x).s
```

Data Preprocessing

Data Preprocessing question_title

In [ ]:

```
target_columns = list(sample_submission.columns)[1:]
```

In [ ]:

```
print(len(target_columns))
print(target_columns)
```

```
30
['question_asker_intent_understanding', 'question_body_critical', 'question_
conversational', 'question_expect_short_answer', 'question_fact_seeking', 'q
uestion_has_commonly_accepted_answer', 'question_interestingness_others', 'q
uestion_interestingness_self', 'question_multi_intent', 'question_not_really
_a_question', 'question_opinion_seeking', 'question_type_choice', 'question_
type_compare', 'question_type_consequence', 'question_type_definition', 'que
stion_type_entity', 'question_type_instructions', 'question_type_procedure',
'question_type_reason_explanation', 'question_type_spelling', 'question_well
_written', 'answer_helpful', 'answer_level_of_information', 'answer_plausibl
e', 'answer_relevance', 'answer_satisfaction', 'answer_type_instructions',
'answer_type_procedure', 'answer_type_reason_explanation', 'answer_well_writ
ten']
```

In [ ]:

```
final_dataset = train_data.drop(target_columns, axis=1)
final_dataset_target = train_data[target_columns].copy()
```

In [ ]:

```
print(final_dataset.shape)
print(final_dataset_target.shape)
```

```
(6079, 20)
(6079, 30)
```

In [ ]:

```
final_dataset.columns
```

Out[58]:

```
Index(['qa_id', 'question_title', 'question_body', 'question_user_name',
       'question_user_page', 'answer', 'answer_user_name', 'answer_user_pag
e',
       'url', 'category', 'host', 'question_title_num_chars',
       'question_body_num_chars', 'answer_num_chars',
       'question_title_num_words', 'question_body_num_words',
       'answer_num_words', 'question_title_num_unique_words',
       'question_body_num_unique_words', 'answer_num_unique_words'],
      dtype='object')
```

In [ ]:

```
# printing some random reviews comment Title
print(final_dataset['question_title'].values[0])
print("="*50)
print(final_dataset['question_title'].values[50])
print("="*50)
print(final_dataset['question_title'].values[100])
print("="*50)
print(final_dataset['question_title'].values[1000])
print("="*50)
print(final_dataset['question_title'].values[5000])
print("="*50)
```

```
What am I losing when using extension tubes instead of a macro lens?
==================================================
AES using derived keys / IVs. Does it introduce a weakness?
==================================================
Where exactly is the London Shoreditch National Express Coach Stop?
==================================================
Using a Wiener Filter to Estimate a Transfer Function
==================================================
Do I need Android SDK to connect my phone in USB debug mode?
==================================================
```

In [ ]:

```
# Removing HTML Tag , \r tags, \n (enter) with space Removed all Special Character
from tqdm import tqdm
preprocessed_question_title= []
# tqdm is for printing the status bar
for sentance in tqdm(final_dataset['question_title'].values):
    sentance = sentance.replace('\r', ' ')
    sentance = sentance.replace('\\"', ' ')
    sentance = sentance.replace('\n', ' ')
    sentance = re.sub(r"http\S+", "", sentance)
    sentance = re.sub(r'[^\w]', ' ', sentance)
    sentance = re.sub(r"\s+", " ", sentance)
    sentance = re.sub('[^A-Za-z0-9]+', ' ', sentance)
    # https://gist.github.com/sebleier/554280
    preprocessed_question_title.append(sentance.lower().strip())
final_dataset['preprocessed_question_title'] = preprocessed_question_title
final_dataset.drop(['question_title'], axis=1, inplace=True)
```

```
100%|██████████| 6079/6079 [00:00<00:00, 58175.27it/s]
```

In [ ]:

```
# printing some random reviews comment Title
print(final_dataset['preprocessed_question_title'].values[0])
print("="*50)
print(final_dataset['preprocessed_question_title'].values[50])
print("="*50)
print(final_dataset['preprocessed_question_title'].values[100])
print("="*50)
print(final_dataset['preprocessed_question_title'].values[1000])
print("="*50)
print(final_dataset['preprocessed_question_title'].values[5000])
print("="*50)
```

```
what am i losing when using extension tubes instead of a macro lens
==================================================
aes using derived keys ivs does it introduce a weakness
==================================================
where exactly is the london shoreditch national express coach stop
==================================================
using a wiener filter to estimate a transfer function
==================================================
do i need android sdk to connect my phone in usb debug mode
==================================================
```

Data Preprocessing question_body

In [ ]:

```
# printing some random reviews comment Title
print(final_dataset['question_body'].values[0])
print("="*50)
print(final_dataset['question_body'].values[50])
print("="*50)
print(final_dataset['question_body'].values[100])
print("="*50)
print(final_dataset['question_body'].values[1000])
print("="*50)
print(final_dataset['question_body'].values[5000])
print("="*50)
```

```
After playing around with macro photography on-the-cheap (read: reversed len
s, rev. lens mounted on a straight lens, passive extension tubes), I would l
ike to get further with this. The problems with the techniques I used is tha
t focus is manual and aperture control is problematic at best. This limited
my setup to still subjects (read: dead insects) Now, as spring is approachin
g, I want to be able to shoot live insects. I believe that for this, autofoc
us and settable aperture will be of great help.

So, one obvious but expensive option is a macro lens (say, EF 100mm Macro) H
owever, I am not really interested in yet another prime lens. An alternative
is the electrical extension tubes.

Except for maximum focusing distance, what am I losing when using tubes (cou
pled with a fine lens, say EF70-200/2.8) instead of a macro lens?

==================================================
I'm looking for an efficient way to encrypt multiple fields in a database wi
th AES using a single global key, used throughout a large web application.

Obviously in order to re-use this key, a unique random IV is required for ea
ch field that is to be encrypted.

I'd rather not introduce more fields to the database to store each of these
IVs, so the programatic approach seems to be to derive these IVs some how.

I'm toying with using either:

key = sha256(global_key + table_name)
iv = sha256(column_name + primary_key)


Or even simply:

key = global_key
iv = sha256(table_name + column_name + primary_key)


I'm leaning towards the former to generate per-table keys.

I've already read that the IVs do not need to be kept secret. So I'm working
on the assumption that a derived key or IV (even if the algorithm becomes kn
own), is no more insecure than any other non-secret IV, as long as the origi
nal key remains secret.

The question is:

Is there a fatal flaw in my approach? Am I introducing any serious weaknesse
```

```
s that, in the event that an adversary obtains a copy of the database, would
make it easier for them to retrieve the plaintext data?

I realise that is potentially soliciting one word answers.

Suggestions for alternate / better schemes very much welcomed, as well as re
ferences to existing works and how they implement similar scenarios.

==================================================
For some reason the rubbish website shows that the Shoreditch stop is just o
ff the Ivory Coast. Any idea where it actually is?

==================================================
As a follow-on to this question about estimating a transfer function of an u
nknown system using a Wiener filter,


How would you put a minimum MSE criteria on how well the estimated filter we
ights matched the actual transfer function of the system? [Suppose you neede
d the MSE to be no more than -50dB]?
How would you change his formulation if you wanted poles as well as zeroes
(an IIR rather than an FIR filter)?



==================================================
I'm following the steps provided here to root my Samsung Captivate (Galaxy-
S).  I install the USB drivers in the link provided.  Whenever I connect my
phone, I get the error There was a problem installing this hardware... SAMSU
NG Android Composite ADB Interface.  I do have USB Debug mode checked on my
phone.

The googling I have done on this issue mention downloading the Android SDK,
but I have heard no mention of needing this on the XDA developers forum or i
n any other conversation about rooting.  So, I wanted to ensure that downloa
ding the Android SDK was necessary, or would even fix my problem before I bo
ther installing it and its dependencies (Java JDK).  I'm running Windows XP.

Note:  Although I'm running a 64-bit machine, I Installed the x86 Samsung Dr
ivers since Windows XP is a 32-bit OS.  I hope that's right.




==================================================
```

In [ ]:

```
# Removing HTML Tag , \r tags, \n (enter) with space Removed all Special Character
from tqdm import tqdm
preprocessed_question_body= []
# tqdm is for printing the status bar
for sentance in tqdm(final_dataset['question_body'].values):
    sentance = sentance.replace('\r', ' ')
    sentance = sentance.replace('\\"', ' ')
    sentance = sentance.replace('\n', ' ')
    sentance = re.sub(r"http\S+", "", sentance)
    sentance = re.sub(r'[^\w]', ' ', sentance)
    sentance = re.sub(r"\s+", " ", sentance)
    sentance = re.sub('[^A-Za-z0-9]+', ' ', sentance)
    # https://gist.github.com/sebleier/554280
    preprocessed_question_body.append(sentance.lower().strip())
final_dataset['preprocessed_question_body'] = preprocessed_question_body
final_dataset.drop(['question_body'], axis=1, inplace=True)
```

```
100%|██████████| 6079/6079 [00:01<00:00, 6039.67it/s]
```

In [ ]:

```
# printing some random reviews comment Title
print(final_dataset['preprocessed_question_body'].values[0])
print("="*50)
print(final_dataset['preprocessed_question_body'].values[50])
print("="*50)
print(final_dataset['preprocessed_question_body'].values[100])
print("="*50)
print(final_dataset['preprocessed_question_body'].values[1000])
print("="*50)
print(final_dataset['preprocessed_question_body'].values[5000])
print("="*50)
```

```
after playing around with macro photography on the cheap read reversed lens
rev lens mounted on a straight lens passive extension tubes i would like to
get further with this the problems with the techniques i used is that focus
is manual and aperture control is problematic at best this limited my setup
to still subjects read dead insects now as spring is approaching i want to b
e able to shoot live insects i believe that for this autofocus and settable
aperture will be of great help so one obvious but expensive option is a macr
o lens say ef 100mm macro however i am not really interested in yet another
prime lens an alternative is the electrical extension tubes except for maxim
um focusing distance what am i losing when using tubes coupled with a fine l
ens say ef70 200 2 8 instead of a macro lens
==================================================
i m looking for an efficient way to encrypt multiple fields in a database wi
th aes using a single global key used throughout a large web application obv
iously in order to re use this key a unique random iv is required for each f
ield that is to be encrypted i d rather not introduce more fields to the dat
abase to store each of these ivs so the programatic approach seems to be to
derive these ivs some how i m toying with using either key sha256 global key
table name iv sha256 column name primary key or even simply key global key i
v sha256 table name column name primary key i m leaning towards the former t
o generate per table keys i ve already read that the ivs do not need to be k
ept secret so i m working on the assumption that a derived key or iv even if
the algorithm becomes known is no more insecure than any other non secret iv
as long as the original key remains secret the question is is there a fatal
flaw in my approach am i introducing any serious weaknesses that in the even
t that an adversary obtains a copy of the database would make it easier for
them to retrieve the plaintext data i realise that is potentially soliciting
one word answers suggestions for alternate better schemes very much welcomed
as well as references to existing works and how they implement similar scena
rios
==================================================
for some reason the rubbish website shows that the shoreditch stop is just o
ff the ivory coast any idea where it actually is
==================================================
as a follow on to this question about estimating a transfer function of an u
nknown system using a wiener filter how would you put a minimum mse criteria
on how well the estimated filter weights matched the actual transfer functio
n of the system suppose you needed the mse to be no more than 50db how would
you change his formulation if you wanted poles as well as zeroes an iir rath
er than an fir filter
==================================================
i m following the steps provided here to root my samsung captivate galaxy s
i install the usb drivers in the link provided whenever i connect my phone i
get the error there was a problem installing this hardware samsung android c
omposite adb interface i do have usb debug mode checked on my phone the goog
ling i have done on this issue mention downloading the android sdk but i hav
e heard no mention of needing this on the xda developers forum or in any oth
```

```
er conversation about rooting so i wanted to ensure that downloading the and
roid sdk was necessary or would even fix my problem before i bother installi
ng it and its dependencies java jdk i m running windows xp note although i m
running a 64 bit machine i installed the x86 samsung drivers since windows x
p is a 32 bit os i hope that s right
==================================================
```

Data Preprocessing question_answer

In [ ]:

```python
# printing some random reviews comment Title
print(final_dataset['answer'].values[0])
print("="*50)
print(final_dataset['answer'].values[50])
print("="*50)
print(final_dataset['answer'].values[100])
print("="*50)
print(final_dataset['answer'].values[1000])
print("="*50)
print(final_dataset['answer'].values[5000])
print("="*50)
```

```
I just got extension tubes, so here's the skinny.


  ...what am I losing when using tubes...?


A very considerable amount of light!  Increasing that distance from the end
of the lens to the sensor can cut your light several stops.  Combined with t
he fact that you'll usually shoot stopped down - expect to need to increase
your ISO considerably.

The fact the macro's are usually considered very very sharp, although I beli
eve that 70-200mm 2.8 is supposed to be quite sharp.

The ultra low distortion typical of many macros.

I wouldn't worry too much about the bokeh since the DOF will still be quite
limited.

Coupled on my 50mm, a full 60mm'ish extension tube results in a DOF of about
a couple inches in front of the lens.  On my 70-300, its probably around 2-3
feet in front of the lens to about a foot in front of the lens.

==================================================
A potentially better approach would be to store the IV and ciphertext in one
column. This way, you can generate IVs in the way most appropriate for your
choice of encryption mode while also not having to add columns.

Something like "$AES-128-CBC$" + Base64.encode64(iv) + "$" + Base64.encode64
(ciphertext) is similar to the format used in crypt, easily parseable, and b
eing Base64-encoded is slightly more convenient when doing queries on the da
tabase using command-line clients.

==================================================
The National Express website is presumably the one you mean, where it shows
it off the African coast.

However, if you look further down the page, it says:


  London (Shoreditch)

  Bethnal Green Rd (to Stansted Airport: Stop J

  opp Overground Stn; or

  from Stansted: Stop K)
```

```
Bethnal Green road on Google Maps clearly shows the road  running west-east,
with the Overground station indicated on the same map.

Hope that helps!

==================================================

The desired MSE is application dependent, so there can be no general
rule. If the approximation doesn't satisfy your needs you can
increase the filter length to obtain a better match.
There is no straightforward way to change the FIR Wiener filter solution to
an IIR solution because the IIR formulation results in a set of nonlinear eq
uations which have no closed-form solution. The IIR solution might also be u
nstable, so FIR filters are a much more practical choice when computing a Wi
ener filter.


==================================================
No, you don't need to install the Android SDK.  The SDK's drivers don't work
for the Galaxy S, actually, at least not the last time I tried.

You best bet is to download Samsung Kies and update the drivers through it,
as per this answer to another question.  You can get Kies most easily from S
amsung UK here.

==================================================
```

In [ ]:

```python
# Removing HTML Tag , \r tags, \n (enter) with space Removed all Special Character
from tqdm import tqdm
preprocessed_answer_body= []
# tqdm is for printing the status bar
for sentance in tqdm(final_dataset['answer'].values):
    sentance = sentance.replace('\r', ' ')
    sentance = sentance.replace('\\"', ' ')
    sentance = sentance.replace('\n', ' ')
    sentance = re.sub(r"http\S+", "", sentance)
    sentance = re.sub(r'[^\w]', ' ', sentance)
    sentance = re.sub(r"\s+", " ", sentance)
    sentance = re.sub('[^A-Za-z0-9]+', ' ', sentance)
    # https://gist.github.com/sebleier/554280
    preprocessed_answer_body.append(sentance.lower().strip())
final_dataset['preprocessed_answer_body'] = preprocessed_answer_body
final_dataset.drop(['answer'], axis=1, inplace=True)
```

```
100%|██████████| 6079/6079 [00:01<00:00, 6020.05it/s]
```

In [ ]:

```
# printing some random reviews comment Title
print(final_dataset['preprocessed_answer_body'].values[0])
print("="*50)
print(final_dataset['preprocessed_answer_body'].values[50])
print("="*50)
print(final_dataset['preprocessed_answer_body'].values[100])
print("="*50)
print(final_dataset['preprocessed_answer_body'].values[1000])
print("="*50)
print(final_dataset['preprocessed_answer_body'].values[5000])
print("="*50)
```

```
i just got extension tubes so here s the skinny what am i losing when using
tubes a very considerable amount of light increasing that distance from the
end of the lens to the sensor can cut your light several stops combined with
the fact that you ll usually shoot stopped down expect to need to increase y
our iso considerably the fact the macro s are usually considered very very s
harp although i believe that 70 200mm 2 8 is supposed to be quite sharp the
ultra low distortion typical of many macros i wouldn t worry too much about
the bokeh since the dof will still be quite limited coupled on my 50mm a ful
l 60mm ish extension tube results in a dof of about a couple inches in front
of the lens on my 70 300 its probably around 2 3 feet in front of the lens t
o about a foot in front of the lens
==================================================
a potentially better approach would be to store the iv and ciphertext in one
column this way you can generate ivs in the way most appropriate for your ch
oice of encryption mode while also not having to add columns something like
aes 128 cbc base64 encode64 iv base64 encode64 ciphertext is similar to the
format used in crypt easily parseable and being base64 encoded is slightly m
ore convenient when doing queries on the database using command line clients
==================================================
the national express website is presumably the one you mean where it shows i
t off the african coast however if you look further down the page it says lo
ndon shoreditch bethnal green rd to stansted airport stop j opp overground s
tn or from stansted stop k bethnal green road on google maps clearly shows t
he road running west east with the overground station indicated on the same
map hope that helps
==================================================
the desired mse is application dependent so there can be no general rule if
the approximation doesn t satisfy your needs you can increase the filter len
gth to obtain a better match there is no straightforward way to change the f
ir wiener filter solution to an iir solution because the iir formulation res
ults in a set of nonlinear equations which have no closed form solution the
iir solution might also be unstable so fir filters are a much more practical
choice when computing a wiener filter
==================================================
no you don t need to install the android sdk the sdk s drivers don t work fo
r the galaxy s actually at least not the last time i tried you best bet is t
o download samsung kies and update the drivers through it as per this answer
to another question you can get kies most easily from samsung uk here
==================================================
```

Data Preprocessing question

Detailed Conclusion Exploratory Data Analysis and Feature Engineering

Conclusion Distribution of Host(from which website Question & Answers collected)

In Training DataSet Stackoverflow.com from which most website Question & Answers collected over 20.6% and 1253 datapoint. english.stackexchange.com has contributed 3.77 % and 229 in DataSet. In Testing DataSet Stackoverflow.com from which most website Question & Answers collected over 21.6% and 103 datapoint. english.stackexchange.com has contributed 4.2 % and 20 in DataSet.

Conclusion Distribution of categories in training data in % and Testting Data

Distribution of Categories is a Categorical Data conatin Technology,StackoverFlow,Culture , Science and Life arts Technology and Stackoverflow has contributed Maximum in training as well as Testing Data set Technology = 40% in Training data set and 42.85 % in testing Data set.

Conclusion Common Features values in training and test data

Above Ven diagram shows that common feature in training and testing Data set There no common question_title present in traning and testing dataset.i.e all question title is unique in testing dataset. The Most common Feature present in training as well as testing is answer_user_name is 405

Distribution for Question Title

Question title having Number of wods lies between 25 to 50 contribtes more in training as well as testing dataset

Distribution for Question

Question Body having Number of wods lies between 300 to 500 contribtes more in training as well as testing dataset

Distribution for Question answer

Question Answer having Number of words lies between 300 to 500 contribtes more in training as well as testing dataset

Conclusion Question

Word 'using' having maximum Number of Occurence in train as well as test data Use ,-, files word also occur in train as well as in test data with almost same Frequency. The First three word in train as well as in test Data is same after word frequecy start changing.

Conclusion Title

semicolon having maximum Number of Occurence in train as well as test data ';' ,'=', '"' also occur in train as well as in test data with almost same Frequency. The First three word in train as well as in test Data is same after word frequecy start changing.

Conclusion Answer

'using' having maximum Number of Occurence in train as well as test data 'using' ,'use', '- also occur in train as well as in test data with almost same Frequency. The First three word in train as well as in test Data is same after word frequecy start changing.

Conslusion Distribution of all Target Features vs Category

- The above plot a informative chart where we can get the difference between the categories to each target feature.
- question body critical" has an interesting distribution between the different categories has lot of variation.
- question_asker_intent_understanding doesn't show lot varition vs catrgory all 25-75 percentile is same only.
- From the Box Plot question body critical show lot of varition against category
- Target Variable question_not_really_question show lot of varition against category.
- Rest all variable does not have very much variance.

Conclusion Frequency vs Question Related Column , Answer Related Column

- From the above Histogram we can conclude that Frequency answer related target has value grater than 0.5
- From the above Histogram we can conclude that Frequency question related target has value grater of 0 ad second largest is 1.

Conclusion Variable Correlations Question

- The above variable correlation heat map answer_related_target_cols describe how answer related the feature related with each other
- As Answer plausable and answer helpfull is very Related with Each other.

Conclusion Variable Correlations Question

- The above variable correlation heat map question_related_target_cols describe how question related the feature related with each other
- As question instrestingness self and question instrestingness other is very Related with Each other.

Feature Engineering

- Number of characters in the question_title

- Number of characters in the question_body
- Number of characters in the answer
- Number of words in the question_title
- Number of words in the question_body
- Number of words in the answer
- Number of unique words in the question_title
- Number of unique words in the question_body
- Number of unique words in the answer

In [ ]:

```
# tensorflow_version 2.x
import tensorflow as tf
print(tf.__version__)
```

```
2.2.0
```

Deep Learning LSTM

In [ ]:

```
from keras.layers import Input, Dense
from keras.models import Model
from keras.layers import LSTM,Bidirectional
import keras
from keras.regularizers import l2
from keras.layers import LeakyReLU
from keras.layers.normalization import BatchNormalization
from keras.layers import Reshape,Concatenate
from numpy import array
from numpy import asarray
from numpy import zeros
from keras.preprocessing.text import Tokenizer
from keras.preprocessing.sequence import pad_sequences
from keras.models import Sequential
from keras.layers import Dense
from keras.layers import Flatten
from keras.layers import Embedding
from keras.layers.core import Dense, Dropout
import tensorflow_hub as hub
from absl import logging
```

```
Using TensorFlow backend.
```

In [ ]:

```
module_url = "https://tfhub.dev/google/universal-sentence-encoder/4"
model = hub.load(module_url)
print ("module %s loaded" % module_url)
def embed(input):
  return model(input)
```

```
module https://tfhub.dev/google/universal-sentence-encoder/4 (https://tfhub.
dev/google/universal-sentence-encoder/4) loaded
```

In [ ]:

```
from keras.layers import Input, Lambda, Dense
word = "Elephant"
sentence = "I am a sentence for which I would like to get its embedding."
paragraph = (
    "Universal Sentence Encoder embeddings also support short paragraphs. "
    "There is no hard limit on how long the paragraph is. Roughly, the longer "
    "the more 'diluted' the embedding will be.")
messages = [word, sentence, paragraph]

# Reduce logging output.
logging.set_verbosity(logging.ERROR)

message_embeddings = embed(['Hello Deelip'])
```

In [ ]:

```
final_dataset.columns
```

Out[72]:

```
Index(['qa_id', 'question_user_name', 'question_user_page', 'answer_user_nam
e',
       'answer_user_page', 'url', 'category', 'host',
       'question_title_num_chars', 'question_body_num_chars',
       'answer_num_chars', 'question_title_num_words',
       'question_body_num_words', 'answer_num_words',
       'question_title_num_unique_words', 'question_body_num_unique_words',
       'answer_num_unique_words', 'preprocessed_question_title',
       'preprocessed_question_body', 'preprocessed_answer_body'],
      dtype='object')
```

In [ ]:

```
print(final_dataset.shape)
print("=="*62)
from sklearn.model_selection import train_test_split
project_data_train, project_data_cv, result_data_train, result_data_cv = train_test_split(f
print(project_data_train.shape,project_data_cv.shape)
print(result_data_train.shape,result_data_cv.shape)
```

```
(6079, 20)
============================================================================
================================================
(5471, 20) (608, 20)
(5471, 30) (608, 30)
```

One Hot Encoding of Categorical Feature

In [ ]:

```
# Make Data Model ready- Encoding category
print("Before vectorizations")

print(project_data_train.shape, result_data_train.shape)
print(project_data_cv.shape, result_data_cv.shape)
vectorizer = CountVectorizer()
vectorizer.fit(final_dataset['category'].values) # fit has to happen only on train data

# we use the fitted CountVectorizer to convert the text to vector
#
X_train_category = vectorizer.transform(project_data_train['category'].values)
X_cv_category =  vectorizer.transform(project_data_cv['category'].values)

print("After vectorizations")
print(X_train_category.shape, result_data_train.shape)
print(X_cv_category.shape, result_data_cv.shape)
print(vectorizer.get_feature_names())
print("="*100)
```

```
Before vectorizations
(5471, 20) (5471, 30)
(608, 20) (608, 30)
After vectorizations
(5471, 5) (5471, 30)
(608, 5) (608, 30)
['culture', 'life_arts', 'science', 'stackoverflow', 'technology']
============================================================================
========================
```

In [ ]:

```
# Make Data Model ready- Encoding category
print("Before vectorizations")

print(project_data_train.shape, result_data_train.shape)
print(project_data_cv.shape, result_data_cv.shape)
vectorizer = CountVectorizer()
vectorizer.fit(final_dataset['host'].values) # fit has to happen only on train data

# we use the fitted CountVectorizer to convert the text to vector
#
X_train_host = vectorizer.transform(project_data_train['host'].values)
X_cv_host =  vectorizer.transform(project_data_cv['host'].values)

print("After vectorizations")
print(X_train_host.shape, result_data_train.shape)
print(X_cv_host.shape, result_data_cv.shape)
print(vectorizer.get_feature_names())
print("="*100)
```

```
Before vectorizations
(5471, 20) (5471, 30)
(608, 20) (608, 30)
After vectorizations
(5471, 62) (5471, 30)
(608, 62) (608, 30)
['academia', 'android', 'anime', 'apple', 'askubuntu', 'bicycles', 'biolog
y', 'blender', 'boardgames', 'chemistry', 'christianity', 'codereview', 'co
m', 'cooking', 'crypto', 'cs', 'dba', 'diy', 'drupal', 'dsp', 'electronics',
'ell', 'english', 'expressionengine', 'gamedev', 'gaming', 'gis', 'graphicde
sign', 'judaism', 'magento', 'math', 'mathematica', 'mathoverflow', 'mechani
cs', 'meta', 'money', 'movies', 'music', 'net', 'photo', 'physics', 'program
mers', 'raspberrypi', 'robotics', 'rpg', 'salesforce', 'scifi', 'security',
'serverfault', 'sharepoint', 'softwarerecs', 'stackexchange', 'stackoverflo
w', 'stats', 'superuser', 'tex', 'travel', 'unix', 'ux', 'webapps', 'webmast
ers', 'wordpress']
============================================================================
========================
```

In [ ]:

```
# Make Data Model ready- Encoding Customer city

vectorizer = CountVectorizer()
vectorizer.fit(final_dataset['category'].values) # fit has to happen only on train data
print(vectorizer.get_feature_names()[:20])
category =  vectorizer.get_feature_names()
print("=="*62)
print(len(category))
category_input = Input(shape =(len(category),), name='category',)
category_emb = Embedding(len(category), 2, input_length=len(category))(category_input)
category_flat = Flatten()(category_emb)
```

```
['culture', 'life_arts', 'science', 'stackoverflow', 'technology']
============================================================================
================================================
5
```

In [ ]:

```
# Make Data Model ready- Encoding Customer city

vectorizer = CountVectorizer()
vectorizer.fit(final_dataset['host'].values) # fit has to happen only on train data
print(vectorizer.get_feature_names()[:20])
host =  vectorizer.get_feature_names()
print("=="*62)
print(len(host))
host_input = Input(shape =(len(host),), name='host',)
host_emb = Embedding(len(host), 2, input_length=len(host))(host_input)
host_flat = Flatten()(host_emb)
```

```
['academia', 'android', 'anime', 'apple', 'askubuntu', 'bicycles', 'biolog
y', 'blender', 'boardgames', 'chemistry', 'christianity', 'codereview', 'co
m', 'cooking', 'crypto', 'cs', 'dba', 'diy', 'drupal', 'dsp']
============================================================================
================================================
62
```

Numerical Field

In [ ]:

```
num_field_train = np.concatenate((project_data_train['question_title_num_chars'].values.res
num_field_cv = np.concatenate((project_data_cv['question_title_num_chars'].values.reshape(-
```

In [ ]:

```
from sklearn.preprocessing import StandardScaler
scalar = StandardScaler()
num_field_train_scalar = scalar.fit_transform(num_field_train)
num_field_cv_scalar = scalar.transform(num_field_cv)
```

In [ ]:

```
num_field_input =  Input(shape=(9,), name="num_field_layer")
num_field_dense = Dense(64, activation='relu',kernel_initializer='he_normal',kernel_regular
num_field_dense = Dropout(0.4)(num_field_dense)
```

In [ ]:

```
# https://www.kaggle.com/kabure/qa-eda-and-nlp-modelling-insights-vis-bert/data
def compute_spearmanr_ignore_nan(trues, preds):
    rhos = []
    for tcol, pcol in zip(np.transpose(trues), np.transpose(preds)):
        rhos.append(spearmanr(tcol, pcol).correlation)
    return np.nanmean(rhos)
```

In [ ]:

```
def UniversalEmbedding(x):
    return embed(tf.squeeze(tf.cast(x, tf.string)))
```

In [ ]:

```
embed_size = 512 #must be 512 for univerasl embedding layer

input_text1 = Input(shape=(1,), dtype=tf.string)
embedding1 = Lambda(UniversalEmbedding, output_shape=(embed_size,))(input_text1)
input_text2 = Input(shape=(1,), dtype=tf.string)
embedding2 = Lambda(UniversalEmbedding, output_shape=(embed_size,))(input_text2)
input_text3 = Input(shape=(1,), dtype=tf.string)
embedding3 = Lambda(UniversalEmbedding, output_shape=(embed_size,))(input_text3)
```

In [ ]:

```
embedding3.shape
```

Out[84]:

```
TensorShape([None, 512])
```

In [ ]:

```
input_columns = ['preprocessed_question_title','preprocessed_question_body','preprocessed_a
```

In [ ]:

```
X1 = project_data_train[input_columns[0]].values
X2 = project_data_train[input_columns[1]].values
X3 = project_data_train[input_columns[2]].values

X_train = [X1,X2,X3]


X_train = [X1,X2,X3,X_train_category,X_train_host,num_field_train_scalar]
```

In [ ]:

```
CV1 = project_data_cv[input_columns[0]].values
CV2 = project_data_cv[input_columns[1]].values
CV3 = project_data_cv[input_columns[2]].values

x_cv = [CV1,CV2,CV3,X_cv_category,X_cv_host,num_field_cv_scalar]
```

In [ ]:

```
y_train =  result_data_train.values
y_cv =  result_data_cv.values
```

In [ ]:

```
concat_layers = []
concat_layers.append(embedding1)
concat_layers.append(embedding2)
concat_layers.append(embedding3)
concat_layers.append(category_flat)
concat_layers.append(host_flat)
concat_layers.append(num_field_dense)
```

In [ ]:

```
concat_layers = Concatenate()(concat_layers)
```

In [ ]:

```
concat_layers= Dense(512,activation='relu',kernel_initializer='he_normal',kernel_regularize
concat_layers = BatchNormalization()(concat_layers)
concat_layers= Dropout(0.4)(concat_layers)

# concat_layers= Dense(128,activation='relu',kernel_initializer='he_normal',kernel_regulari
# concat_layers = BatchNormalization()(concat_layers)
# concat_layers= Dropout(0.4)(concat_layers)

concat_layers= Dense(64,activation='relu',kernel_initializer='he_normal',kernel_regularizer
concat_layers = BatchNormalization()(concat_layers)

concat_layers= Dropout(0.4)(concat_layers)
concat_layers = BatchNormalization()(concat_layers)


output=Dense(len(target_columns), activation='sigmoid')(concat_layers)
model_1 = Model(inputs=[input_text1,input_text2,input_text3,category_input,host_input,num_f
```

In [ ]:

```
model_1.summary()
```

```
Model: "model_1"
____________________________________________________________________________
______________________
Layer (type)                    Output Shape         Param #     Connected t
o
============================================================================
======================
category (InputLayer)           (None, 5)            0
____________________________________________________________________________
______________________
host (InputLayer)               (None, 62)           0
____________________________________________________________________________
______________________
num_field_layer (InputLayer)    (None, 9)            0
____________________________________________________________________________
______________________
input_1 (InputLayer)            (None, 1)            0
____________________________________________________________________________
______________________
input_2 (InputLayer)            (None, 1)            0
____________________________________________________________________________
______________________
input_3 (InputLayer)            (None, 1)            0
____________________________________________________________________________
______________________
embedding_1 (Embedding)         (None, 5, 2)         10          category[0]
[0]
____________________________________________________________________________
______________________
embedding_2 (Embedding)         (None, 62, 2)        124         host[0][0]
____________________________________________________________________________
______________________
dense_1 (Dense)                 (None, 64)           640         num_field_l
ayer[0][0]
____________________________________________________________________________
______________________
lambda_1 (Lambda)               (None, 512)          0           input_1[0]
[0]
____________________________________________________________________________
______________________
lambda_2 (Lambda)               (None, 512)          0           input_2[0]
[0]
____________________________________________________________________________
______________________
lambda_3 (Lambda)               (None, 512)          0           input_3[0]
[0]
____________________________________________________________________________
______________________
flatten_1 (Flatten)             (None, 10)           0           embedding_1
[0][0]
____________________________________________________________________________
______________________
flatten_2 (Flatten)             (None, 124)          0           embedding_2
[0][0]
____________________________________________________________________________
______________________
dropout_1 (Dropout)             (None, 64)           0           dense_1[0]
```

```
[0]
____________________________________________________________________________________________
______________________
concatenate_1 (Concatenate)     (None, 1734)         0           lambda_1[0]
[0]
                                                                 lambda_2[0]
[0]
                                                                 lambda_3[0]
[0]
                                                                 flatten_1
[0][0]
                                                                 flatten_2
[0][0]
                                                                 dropout_1
[0][0]
____________________________________________________________________________________________
______________________
dense_2 (Dense)                 (None, 512)          888320      concatenate
_1[0][0]
____________________________________________________________________________________________
______________________
batch_normalization_1 (BatchNor (None, 512)          2048        dense_2[0]
[0]
____________________________________________________________________________________________
______________________
dropout_2 (Dropout)             (None, 512)          0           batch_norma
lization_1[0][0]
____________________________________________________________________________________________
______________________
dense_3 (Dense)                 (None, 64)           32832       dropout_2
[0][0]
____________________________________________________________________________________________
______________________
batch_normalization_2 (BatchNor (None, 64)           256         dense_3[0]
[0]
____________________________________________________________________________________________
______________________
dropout_3 (Dropout)             (None, 64)           0           batch_norma
lization_2[0][0]
____________________________________________________________________________________________
______________________
batch_normalization_3 (BatchNor (None, 64)           256         dropout_3
[0][0]
____________________________________________________________________________________________
______________________
dense_4 (Dense)                 (None, 30)           1950        batch_norma
lization_3[0][0]
============================================================================================
======================
Total params: 926,436
Trainable params: 925,156
Non-trainable params: 1,280
____________________________________________________________________________________________
______________________
```

In [ ]:

```
model_1.compile(optimizer='adam', loss='binary_crossentropy',metrics=['mse', 'mae'])
```

In [ ]:

```
history_1 = model_1.fit(X_train,y_train,epochs=60,batch_size=400,verbose=1, validation_data
```

```
Train on 5471 samples, validate on 608 samples
Epoch 1/60
5471/5471 [==============================] - 16s 3ms/step - loss: 1.8465 -
mse: 0.2033 - mae: 0.3927 - val_loss: 1.4888 - val_mse: 0.1666 - val_mae:
0.3735
Epoch 2/60
5471/5471 [==============================] - 12s 2ms/step - loss: 1.3886 -
mse: 0.1834 - mae: 0.3787 - val_loss: 1.1694 - val_mse: 0.1607 - val_mae:
0.3669
Epoch 3/60
5471/5471 [==============================] - 13s 2ms/step - loss: 1.1250 -
mse: 0.1729 - mae: 0.3707 - val_loss: 0.9911 - val_mse: 0.1543 - val_mae:
0.3595
Epoch 4/60
5471/5471 [==============================] - 13s 2ms/step - loss: 0.9778 -
mse: 0.1634 - mae: 0.3611 - val_loss: 0.8882 - val_mse: 0.1459 - val_mae:
0.3494
Epoch 5/60
5471/5471 [==============================] - 13s 2ms/step - loss: 0.8870 -
```

In [ ]:

```
history_1 = model_1.fit(X_train,y_train,epochs=1,batch_size=400,verbose=1, validation_data=
```

```
Train on 5471 samples, validate on 608 samples
Epoch 1/1
5471/5471 [==============================] - 13s 2ms/step - loss: 0.3891 - m
se: 0.0391 - mae: 0.1301 - val_loss: 0.4087 - val_mse: 0.0456 - val_mae: 0.1
421
```

In [ ]:

```
history_1 = model_1.fit(X_train,y_train,epochs=1,batch_size=400,verbose=1, validation_data=
```

```
Train on 5471 samples, validate on 608 samples
Epoch 1/1
5471/5471 [==============================] - 12s 2ms/step - loss: 0.3882 - m
se: 0.0391 - mae: 0.1301 - val_loss: 0.4086 - val_mse: 0.0455 - val_mae: 0.1
428
```

In [ ]:

```
valid_preds = []
valid_preds.append(model_1.predict(x_cv))
```

In [ ]:

```
spear_val = compute_spearmanr_ignore_nan(y_cv, valid_preds[-1])
print('validation score = ', spear_val)
```

```
validation score =  0.349053745237342
```

In [ ]:

```
<h1> Fastext Word Vector and LSTM </h1>
```

In [ ]:

```
import fasttext.util
```

In [ ]:

```
! wget --header="Host: dl.fbaipublicfiles.com" --header="User-Agent: Mozilla/5.0 (Windows N
```

```
--2020-06-18 20:24:28--  https://dl.fbaipublicfiles.com/fasttext/vectors-cra
wl/cc.en.300.vec.gz (https://dl.fbaipublicfiles.com/fasttext/vectors-crawl/c
c.en.300.vec.gz)
Resolving dl.fbaipublicfiles.com (dl.fbaipublicfiles.com)... 104.22.74.142,
 104.22.75.142, 172.67.9.4, ...
Connecting to dl.fbaipublicfiles.com (dl.fbaipublicfiles.com)|104.22.74.142
|:443... connected.
HTTP request sent, awaiting response... 416 Requested Range Not Satisfiable

    The file is already fully retrieved; nothing to do.
```

In [ ]:

```
import gzip
```

Tokenizing the Question title

In [ ]:

```
# prepare tokenizer
t = Tokenizer()
t.fit_on_texts(final_dataset['preprocessed_question_title'])
vocab_size = len(t.word_index) + 1
# integer encode the documents
encoded_docs = t.texts_to_sequences(project_data_train['preprocessed_question_title'])
print(encoded_docs)
# pad documents to a max length of 600 words
max_length = 600
padded_docs_train_question_title = pad_sequences(encoded_docs, maxlen=max_length, padding='

# load the whole embedding into memory
```

```
[[146, 3193, 3194], [24, 167, 1682, 105, 17, 3780, 3781, 280, 130, 2719, 1
8, 28, 576, 58, 638, 22, 325, 399, 921], [237, 6, 6777, 520], [176, 1869,
23, 385, 5, 13, 143, 298, 37, 308, 1524, 176, 721, 1116], [5728, 397, 696,
386, 13, 30, 32, 2855, 1, 2, 201, 800, 4, 3, 3746], [11, 25, 3, 6001, 6,
2, 2004, 1975, 1872], [67, 576, 183, 2217, 164, 187, 576, 183], [554, 13,
30, 57, 5766, 4155, 767, 1115, 554, 5767], [1384, 913, 1, 756, 1630], [142
5, 3, 4119, 10, 2, 2494], [19, 25, 35, 5069, 14, 21, 5070], [11, 7, 3, 440
7, 6, 2, 5962, 4172, 491], [5333, 208, 1, 5334, 47, 40, 1613, 4, 26, 113,
342, 162], [126, 1, 1446, 2012, 105, 53, 2238, 861, 12, 4405, 2162, 4406],
[5, 1, 246, 116, 54, 14, 151, 8, 2071], [794, 949, 2141, 4, 42, 522, 27, 1
416], [479, 587, 7, 6204, 10, 105, 2, 6205, 24, 6206, 72, 7, 42, 934], [5,
1, 246, 116, 54, 14, 151, 8, 2071], [59, 281, 1, 750, 434, 1729, 83, 43],
[916, 2789, 16, 2, 186, 4, 562], [5, 1, 869, 2609, 6591, 634, 6592], [142
0, 14, 26, 275, 706, 254], [2718, 1116, 6, 2, 585, 12, 17, 1680], [1534, 2
712, 52, 2109, 12, 3, 2713, 46, 232, 104], [11, 120, 33, 185, 2, 2836, 283
7, 146, 121, 437, 2838, 16, 2839], [1927, 2474, 397, 1928, 6, 3, 352, 219,
397, 3354, 46, 96, 63, 94, 46, 96, 2475, 8, 397, 1319, 397, 1928], [15, 24
39, 356, 5660, 2812, 10, 5661, 1237, 1735, 566, 1237, 1444, 63, 310, 101
8], [7, 20, 89, 1, 627, 14, 96, 5763, 2228, 3774, 5764, 12, 2, 2876, 146
```

In [ ]:

```python
print(padded_docs_train_question_title[1])
print(type(padded_docs_train_question_title[1]))
print(len(padded_docs_train_question_title[1]))
```

```
[  24  167 1682  105   17 3780 3781  280  130 2719   18   28  576   58
  638   22  325  399  921    0    0    0    0    0    0    0    0    0
    0    0    0    0    0    0    0    0    0    0    0    0    0    0
    0    0    0    0    0    0    0    0    0    0    0    0    0    0
    0    0    0    0    0    0    0    0    0    0    0    0    0    0
    0    0    0    0    0    0    0    0    0    0    0    0    0    0
    0    0    0    0    0    0    0    0    0    0    0    0    0    0
    0    0    0    0    0    0    0    0    0    0    0    0    0    0
    0    0    0    0    0    0    0    0    0    0    0    0    0    0
    0    0    0    0    0    0    0    0    0    0    0    0    0    0
    0    0    0    0    0    0    0    0    0    0    0    0    0    0
    0    0    0    0    0    0    0    0    0    0    0    0    0    0
    0    0    0    0    0    0    0    0    0    0    0    0    0    0
    0    0    0    0    0    0    0    0    0    0    0    0    0    0
    0    0    0    0    0    0    0    0    0    0    0    0    0    0
    0    0    0    0    0    0    0    0    0    0    0    0    0    0
    0    0    0    0    0    0    0    0    0    0    0    0    0    0
    0    0    0    0    0    0    0    0    0    0    0    0    0    0
    0    0    0    0    0    0    0    0    0    0    0    0    0    0
    0    0    0    0    0    0    0    0    0    0    0    0    0    0
    0    0    0    0    0    0    0    0    0    0    0    0    0    0
    0    0    0    0    0    0    0    0    0    0    0    0    0    0
    0    0    0    0    0    0    0    0    0    0    0    0    0    0
    0    0    0    0    0    0    0    0    0    0    0    0    0    0
    0    0    0    0    0    0    0    0    0    0    0    0    0    0
    0    0    0    0    0    0    0    0    0    0    0    0    0    0
    0    0    0    0    0    0    0    0    0    0    0    0    0    0
    0    0    0    0    0    0    0    0    0    0    0    0    0    0
    0    0    0    0    0    0    0    0    0    0    0    0    0    0
    0    0    0    0    0    0    0    0    0    0    0    0    0    0
    0    0    0    0    0    0    0    0    0    0    0    0    0    0
    0    0    0    0    0    0    0    0    0    0    0    0    0    0
    0    0    0    0    0    0    0    0    0    0    0    0    0    0
    0    0    0    0    0    0    0    0    0    0    0    0    0    0
    0    0    0    0    0    0    0    0    0    0    0    0    0    0
    0    0    0    0    0    0    0    0    0    0    0    0    0    0
    0    0    0    0    0    0    0    0    0    0    0    0    0    0
    0    0    0    0    0    0    0    0    0    0    0    0    0    0
    0    0    0    0    0    0    0    0    0    0    0    0    0    0
    0    0    0    0    0    0    0    0    0    0    0    0    0    0
    0    0    0    0    0    0    0    0    0    0    0    0    0    0
    0    0    0    0    0    0    0    0    0    0    0    0    0    0
    0    0    0    0    0    0    0    0    0    0    0    0]
<class 'numpy.ndarray'>
600
```

In [ ]:

```
encoded_docs = t.texts_to_sequences(project_data_cv['preprocessed_question_title'])
padded_docs_cv_question_title = pad_sequences(encoded_docs, maxlen=max_length, padding='pos
print(padded_docs_cv_question_title[1])
print(type(padded_docs_cv_question_title[1]))
print(len(padded_docs_cv_question_title[1]))
```

```
[2597 1374 1174   97  262 3531    8  115   12 3532  310    0    0    0
    0    0    0    0    0    0    0    0    0    0    0    0    0    0
    0    0    0    0    0    0    0    0    0    0    0    0    0    0
    0    0    0    0    0    0    0    0    0    0    0    0    0    0
    0    0    0    0    0    0    0    0    0    0    0    0    0    0
    0    0    0    0    0    0    0    0    0    0    0    0    0    0
    0    0    0    0    0    0    0    0    0    0    0    0    0    0
    0    0    0    0    0    0    0    0    0    0    0    0    0    0
    0    0    0    0    0    0    0    0    0    0    0    0    0    0
    0    0    0    0    0    0    0    0    0    0    0    0    0    0
    0    0    0    0    0    0    0    0    0    0    0    0    0    0
    0    0    0    0    0    0    0    0    0    0    0    0    0    0
    0    0    0    0    0    0    0    0    0    0    0    0    0    0
    0    0    0    0    0    0    0    0    0    0    0    0    0    0
    0    0    0    0    0    0    0    0    0    0    0    0    0    0
    0    0    0    0    0    0    0    0    0    0    0    0    0    0
    0    0    0    0    0    0    0    0    0    0    0    0    0    0
    0    0    0    0    0    0    0    0    0    0    0    0    0    0
    0    0    0    0    0    0    0    0    0    0    0    0    0    0
    0    0    0    0    0    0    0    0    0    0    0    0    0    0
    0    0    0    0    0    0    0    0    0    0    0    0    0    0
    0    0    0    0    0    0    0    0    0    0    0    0    0    0
    0    0    0    0    0    0    0    0    0    0    0    0    0    0
    0    0    0    0    0    0    0    0    0    0    0    0    0    0
    0    0    0    0    0    0    0    0    0    0    0    0    0    0
    0    0    0    0    0    0    0    0    0    0    0    0    0    0
    0    0    0    0    0    0    0    0    0    0    0    0    0    0
    0    0    0    0    0    0    0    0    0    0    0    0    0    0
    0    0    0    0    0    0    0    0    0    0    0    0    0    0
    0    0    0    0    0    0    0    0    0    0    0    0    0    0
    0    0    0    0    0    0    0    0    0    0    0    0    0    0
    0    0    0    0    0    0    0    0    0    0    0    0    0    0
    0    0    0    0    0    0    0    0    0    0    0    0    0    0
    0    0    0    0    0    0    0    0    0    0    0    0    0    0
    0    0    0    0    0    0    0    0    0    0    0    0    0    0
    0    0    0    0    0    0    0    0    0    0    0    0    0    0
    0    0    0    0    0    0    0    0    0    0    0    0    0    0
    0    0    0    0    0    0    0    0    0    0    0    0    0    0
    0    0    0    0    0    0    0    0    0    0    0    0    0    0
    0    0    0    0    0    0    0    0    0    0    0    0    0    0
    0    0    0    0    0    0    0    0    0    0    0    0    0    0
    0    0    0    0    0    0    0    0    0    0    0    0    0    0
    0    0    0    0    0    0    0    0    0    0    0    0]
<class 'numpy.ndarray'>
600
```

Tokenizing the Question Body

In [ ]:

```
# prepare tokenizer
t = Tokenizer()
t.fit_on_texts(final_dataset['preprocessed_question_body'])
vocab_size = len(t.word_index) + 1
# integer encode the documents
encoded_docs = t.texts_to_sequences(project_data_train['preprocessed_question_body'])
print(encoded_docs)
# pad documents to a max length of 600 words
max_length = 600
padded_docs_train_question_body = pad_sequences(encoded_docs, maxlen=max_length, padding='p

# load the whole embedding into memory
```

```
IOPub data rate exceeded.
The notebook server will temporarily stop sending output
to the client in order to avoid crashing it.
To change this limit, set the config variable
`--NotebookApp.iopub_data_rate_limit`.

Current values:
NotebookApp.iopub_data_rate_limit=1000000.0 (bytes/sec)
NotebookApp.rate_limit_window=3.0 (secs)
```

In [ ]:

```python
print(padded_docs_train_question_body[1])
print(type(padded_docs_train_question_body[1]))
print(len(padded_docs_train_question_body[1]))
```

```
[    2    16    34   455  2380  1266    49 13785    98  8730  3684    48
  1005    69    33     9   777    32  1608 13786     2   162    82    11
   108    12     4  1692    98    52   173    17   204    27     4  3462
    98    52   248    17  1266    45    61  2020    75     4   496  4777
   204  7020     5    11     1   593   157     7   666     6   762  2129
   736     9 11362    63   223   194  8730   180     2    35    94    36
    30     1   496  1266  5503    23    47    72   131     4  3327  7020
    24    21   458     3    21   496     0     0     0     0     0     0
     0     0     0     0     0     0     0     0     0     0     0     0
     0     0     0     0     0     0     0     0     0     0     0     0
     0     0     0     0     0     0     0     0     0     0     0     0
     0     0     0     0     0     0     0     0     0     0     0     0
     0     0     0     0     0     0     0     0     0     0     0     0
     0     0     0     0     0     0     0     0     0     0     0     0
     0     0     0     0     0     0     0     0     0     0     0     0
     0     0     0     0     0     0     0     0     0     0     0     0
     0     0     0     0     0     0     0     0     0     0     0     0
     0     0     0     0     0     0     0     0     0     0     0     0
     0     0     0     0     0     0     0     0     0     0     0     0
     0     0     0     0     0     0     0     0     0     0     0     0
     0     0     0     0     0     0     0     0     0     0     0     0
     0     0     0     0     0     0     0     0     0     0     0     0
     0     0     0     0     0     0     0     0     0     0     0     0
     0     0     0     0     0     0     0     0     0     0     0     0
     0     0     0     0     0     0     0     0     0     0     0     0
     0     0     0     0     0     0     0     0     0     0     0     0
     0     0     0     0     0     0     0     0     0     0     0     0
     0     0     0     0     0     0     0     0     0     0     0     0
     0     0     0     0     0     0     0     0     0     0     0     0
     0     0     0     0     0     0     0     0     0     0     0     0
     0     0     0     0     0     0     0     0     0     0     0     0
     0     0     0     0     0     0     0     0     0     0     0     0
     0     0     0     0     0     0     0     0     0     0     0     0
     0     0     0     0     0     0     0     0     0     0     0     0
     0     0     0     0     0     0     0     0     0     0     0     0
     0     0     0     0     0     0     0     0     0     0     0     0
     0     0     0     0     0     0     0     0     0     0     0     0
     0     0     0     0     0     0     0     0     0     0     0     0
     0     0     0     0     0     0     0     0     0     0     0     0
     0     0     0     0     0     0     0     0     0     0     0     0
     0     0     0     0     0     0     0     0     0     0     0     0
     0     0     0     0     0     0     0     0     0     0     0     0
     0     0     0     0     0     0     0     0     0     0     0     0
     0     0     0     0     0     0     0     0     0     0     0     0
     0     0     0     0     0     0     0     0     0     0     0     0
     0     0     0     0     0     0     0     0     0     0     0     0
     0     0     0     0     0     0     0     0     0     0     0     0
     0     0     0     0     0     0     0     0     0     0     0     0
     0     0     0     0     0     0     0     0     0     0     0     0
     0     0     0     0     0     0     0     0     0     0     0     0]
<class 'numpy.ndarray'>
600
```

```
In [ ]:
```

```
encoded_docs = t.texts_to_sequences(project_data_cv['preprocessed_question_body'])
padded_docs_cv_question_body= pad_sequences(encoded_docs, maxlen=max_length, padding='post'
print(padded_docs_cv_question_body[1])
print(type(padded_docs_cv_question_body[1]))
print(len(padded_docs_cv_question_body[1]))
```

```
[    2    56  1818    18    15   424     6    16    95    79     4   314
    26  1680  6000  4500    49     5  1505     8    15   361   600    36
   567    55  3280   240    73     5    11     2   392  2105   110     1
   627  6001   292     2    71     1  1267   361     8    15 16727   309
     6    56     9   633     2    16     3  1014     4    59    48   367
   122    24    25     2  2105   110     4   361   164    61   335     8
     1 16728  7762     6   361  7034    16   126  5664  1117   105   356
    14     1  2122    49  5665    79    45  4933     8  1446  2236     6
   759     2    89   596   333     4   188    18   551  2392   131   144
     1  4500   150   477    50   905     2   209    77    39     2    24
 16729     1  2616  2122    63    56  1818   139  1818    65  2361     6
    70     2    24  2105     1  4500   110     1  1143   158     9    82
    26   102    19    15  4500    54  3198  2361   121     8    65  2361
     2    24  7035     1   204   195   637    20     1   105   969    82
    26    46  2038    53  3195    31  1818  1942    15   204     5 16730
    54 16731   218    94 16732   175     3    21   129    54  1818   139
   161    26  3428     1   356    14  1446  2236     6    15  5077    14
   122  1117    41    40   171   134     2  3002     1    88  1002 16733
   173   292     0     0     0     0     0     0     0     0     0     0
     0     0     0     0     0     0     0     0     0     0     0     0
     0     0     0     0     0     0     0     0     0     0     0     0
     0     0     0     0     0     0     0     0     0     0     0     0
     0     0     0     0     0     0     0     0     0     0     0     0
     0     0     0     0     0     0     0     0     0     0     0     0
     0     0     0     0     0     0     0     0     0     0     0     0
     0     0     0     0     0     0     0     0     0     0     0     0
     0     0     0     0     0     0     0     0     0     0     0     0
     0     0     0     0     0     0     0     0     0     0     0     0
     0     0     0     0     0     0     0     0     0     0     0     0
     0     0     0     0     0     0     0     0     0     0     0     0
     0     0     0     0     0     0     0     0     0     0     0     0
     0     0     0     0     0     0     0     0     0     0     0     0
     0     0     0     0     0     0     0     0     0     0     0     0
     0     0     0     0     0     0     0     0     0     0     0     0
     0     0     0     0     0     0     0     0     0     0     0     0
     0     0     0     0     0     0     0     0     0     0     0     0
     0     0     0     0     0     0     0     0     0     0     0     0
     0     0     0     0     0     0     0     0     0     0     0     0
     0     0     0     0     0     0     0     0     0     0     0     0
     0     0     0     0     0     0     0     0     0     0     0     0
     0     0     0     0     0     0     0     0     0     0     0     0
     0     0     0     0     0     0     0     0     0     0     0     0
     0     0     0     0     0     0     0     0     0     0     0     0
     0     0     0     0     0     0     0     0     0     0     0     0
     0     0     0     0     0     0     0     0     0     0     0     0
     0     0     0     0     0     0     0     0     0     0     0     0
     0     0     0     0     0     0     0     0     0     0     0     0
     0     0     0     0     0     0     0     0     0     0     0     0
     0     0     0     0     0     0     0     0     0     0     0     0
     0     0     0     0     0     0     0     0     0     0     0     0
     0     0     0     0     0     0     0     0     0     0     0     0
     0     0     0     0     0     0     0     0     0     0     0     0]
<class 'numpy.ndarray'>
600
```

Tokenizing the Question answer

In [ ]:

```
# prepare tokenizer
t = Tokenizer()
t.fit_on_texts(final_dataset['preprocessed_answer_body'])
vocab_size = len(t.word_index) + 1
# integer encode the documents
encoded_docs = t.texts_to_sequences(project_data_train['preprocessed_answer_body'])
print(encoded_docs)
# pad documents to a max length of 600 words
max_length = 600
padded_docs_train_question_answer = pad_sequences(encoded_docs, maxlen=max_length, padding=

# load the whole embedding into memory
```

```
IOPub data rate exceeded.
The notebook server will temporarily stop sending output
to the client in order to avoid crashing it.
To change this limit, set the config variable
`--NotebookApp.iopub_data_rate_limit`.

Current values:
NotebookApp.iopub_data_rate_limit=1000000.0 (bytes/sec)
NotebookApp.rate_limit_window=3.0 (secs)
```

In [ ]:

```
print(padded_docs_train_question_answer[1])
print(type(padded_docs_train_question_answer[1]))
print(len(padded_docs_train_question_answer[1]))
```

```
[    9     7    23   429     2   106    71     3   159     5   672    52
  5302  9160    13    38  1861     3   457  4812    57   112   457 10625
    74    30     1  1311    96  5416    70   457 10625   239    56    30
     1  1311    96  1061    70   744   672    36   202   292     2 10626
    32  9150   101   134    30  5416     2 21361   872   413   672     1
   159     5   672    70   663   672    36     1   202    70 10625    36
     1   202  7351     1  1311    96   413    70  2108     1  1311    96
  5416   112 10625    74    84  7351     1  1311    96   413   112  2595
    45   793    70  2108    25  2595  4909     0     0     0     0     0
     0     0     0     0     0     0     0     0     0     0     0     0
     0     0     0     0     0     0     0     0     0     0     0     0
     0     0     0     0     0     0     0     0     0     0     0     0
     0     0     0     0     0     0     0     0     0     0     0     0
     0     0     0     0     0     0     0     0     0     0     0     0
     0     0     0     0     0     0     0     0     0     0     0     0
     0     0     0     0     0     0     0     0     0     0     0     0
     0     0     0     0     0     0     0     0     0     0     0     0
     0     0     0     0     0     0     0     0     0     0     0     0
     0     0     0     0     0     0     0     0     0     0     0     0
     0     0     0     0     0     0     0     0     0     0     0     0
     0     0     0     0     0     0     0     0     0     0     0     0
     0     0     0     0     0     0     0     0     0     0     0     0
     0     0     0     0     0     0     0     0     0     0     0     0
     0     0     0     0     0     0     0     0     0     0     0     0
     0     0     0     0     0     0     0     0     0     0     0     0
     0     0     0     0     0     0     0     0     0     0     0     0
     0     0     0     0     0     0     0     0     0     0     0     0
     0     0     0     0     0     0     0     0     0     0     0     0
     0     0     0     0     0     0     0     0     0     0     0     0
     0     0     0     0     0     0     0     0     0     0     0     0
     0     0     0     0     0     0     0     0     0     0     0     0
     0     0     0     0     0     0     0     0     0     0     0     0
     0     0     0     0     0     0     0     0     0     0     0     0
     0     0     0     0     0     0     0     0     0     0     0     0
     0     0     0     0     0     0     0     0     0     0     0     0
     0     0     0     0     0     0     0     0     0     0     0     0
     0     0     0     0     0     0     0     0     0     0     0     0
     0     0     0     0     0     0     0     0     0     0     0     0
     0     0     0     0     0     0     0     0     0     0     0     0
     0     0     0     0     0     0     0     0     0     0     0     0
     0     0     0     0     0     0     0     0     0     0     0     0
     0     0     0     0     0     0     0     0     0     0     0     0
     0     0     0     0     0     0     0     0     0     0     0     0
     0     0     0     0     0     0     0     0     0     0     0     0
     0     0     0     0     0     0     0     0     0     0     0     0
     0     0     0     0     0     0     0     0     0     0     0     0
     0     0     0     0     0     0     0     0     0     0     0     0
     0     0     0     0     0     0     0     0     0     0     0     0
     0     0     0     0     0     0     0     0     0     0     0     0
     0     0     0     0     0     0     0     0     0     0     0     0]
<class 'numpy.ndarray'>
600
```

In [ ]:

```
encoded_docs = t.texts_to_sequences(project_data_cv['preprocessed_answer_body'])
padded_docs_cv_question_answer= pad_sequences(encoded_docs, maxlen=max_length, padding='pos
print(padded_docs_cv_question_answer[1])
print(type(padded_docs_cv_question_answer[1]))
print(len(padded_docs_cv_question_answer[1]))
```

```
[    1  2534    12  1746  1214    21    15 13285    38   741     1   199
     8     1  1488  1098  1746   130  1746   116  1978    31    43     1
  2498     4    21  2143     1   717    97     1  1098    16 23558   331
   116  1978  1443    66  9757   340     2    15  1844    18  5161 13286
  1746  1214     1   978  2493     7     2  5788     1 23559     6  3479
     9   281    17     1   450  1746  1967   199  3919   236  4466  3483
   116  1978   116  1978  9757  4090  1978     8   116  1978  9757    71
   116  1978   919  6682     2  5788  3875 23560   116  1978  1746 23561
   113   116  1978    88   919  6682     2  3479   281     0     0     0
     0     0     0     0     0     0     0     0     0     0     0     0
     0     0     0     0     0     0     0     0     0     0     0     0
     0     0     0     0     0     0     0     0     0     0     0     0
     0     0     0     0     0     0     0     0     0     0     0     0
     0     0     0     0     0     0     0     0     0     0     0     0
     0     0     0     0     0     0     0     0     0     0     0     0
     0     0     0     0     0     0     0     0     0     0     0     0
     0     0     0     0     0     0     0     0     0     0     0     0
     0     0     0     0     0     0     0     0     0     0     0     0
     0     0     0     0     0     0     0     0     0     0     0     0
     0     0     0     0     0     0     0     0     0     0     0     0
     0     0     0     0     0     0     0     0     0     0     0     0
     0     0     0     0     0     0     0     0     0     0     0     0
     0     0     0     0     0     0     0     0     0     0     0     0
     0     0     0     0     0     0     0     0     0     0     0     0
     0     0     0     0     0     0     0     0     0     0     0     0
     0     0     0     0     0     0     0     0     0     0     0     0
     0     0     0     0     0     0     0     0     0     0     0     0
     0     0     0     0     0     0     0     0     0     0     0     0
     0     0     0     0     0     0     0     0     0     0     0     0
     0     0     0     0     0     0     0     0     0     0     0     0
     0     0     0     0     0     0     0     0     0     0     0     0
     0     0     0     0     0     0     0     0     0     0     0     0
     0     0     0     0     0     0     0     0     0     0     0     0
     0     0     0     0     0     0     0     0     0     0     0     0
     0     0     0     0     0     0     0     0     0     0     0     0
     0     0     0     0     0     0     0     0     0     0     0     0
     0     0     0     0     0     0     0     0     0     0     0     0
     0     0     0     0     0     0     0     0     0     0     0     0
     0     0     0     0     0     0     0     0     0     0     0     0
     0     0     0     0     0     0     0     0     0     0     0     0
     0     0     0     0     0     0     0     0     0     0     0     0
     0     0     0     0     0     0     0     0     0     0     0     0
     0     0     0     0     0     0     0     0     0     0     0     0
     0     0     0     0     0     0     0     0     0     0     0     0
     0     0     0     0     0     0     0     0     0     0     0     0
     0     0     0     0     0     0     0     0     0     0     0     0
     0     0     0     0     0     0     0     0     0     0     0     0
     0     0     0     0     0     0     0     0     0     0     0     0
     0     0     0     0     0     0     0     0     0     0     0     0
     0     0     0     0     0     0     0     0     0     0     0     0]
<class 'numpy.ndarray'>
600
```

In [ ]:

```
from keras.preprocessing.text import Tokenizer
t = Tokenizer()
t.fit_on_texts(final_dataset['preprocessed_question_title'])
vocab_size = len(t.word_index) + 1
```

In [ ]:

```
file = gzip.open('cc.en.300.vec.gz')
```

In [ ]:

```
from tqdm import tqdm
from numpy import asarray
embeddings_index = dict()
for line in tqdm(file):
    values = line.split()
    word = values[0].decode('utf-8')
    coefs = asarray(values[1:], dtype='float32')
    embeddings_index[word] = coefs
file.close()
```

```
2000001it [03:02, 10971.15it/s]
```

In [ ]:

```
embedding_matrix = np.zeros((vocab_size, 300))
for word, i in tqdm(t.word_index.items()):
    embedding_vector = embeddings_index.get(word)
    if embedding_vector is not None:
        embedding_matrix[i] = embedding_vector
```

```
100%|██████████| 7253/7253 [00:00<00:00, 226500.54it/s]
```

In [ ]:

```
print(embedding_matrix.shape)
```

```
(7254, 300)
```

In [ ]:

```
preprocessed_question_title_input = Input(shape=(max_length,), name = "preprocessed_questic
emb = Embedding(vocab_size, 300, weights=[embedding_matrix], input_length=max_length,traina

lstm= LSTM(128,return_sequences=True)(emb)
dropoutlstm = Dropout(0.2)(lstm)
flat_title= Flatten()(dropoutlstm)
```

In [ ]:

```
from keras.preprocessing.text import Tokenizer
t = Tokenizer()
t.fit_on_texts(final_dataset['preprocessed_question_body'])
vocab_size = len(t.word_index) + 1
```

In [ ]:

```
embedding_matrix = np.zeros((vocab_size, 300))
for word, i in tqdm(t.word_index.items()):
    embedding_vector = embeddings_index.get(word)
    if embedding_vector is not None:
        embedding_matrix[i] = embedding_vector
```

```
100%|██████████| 28007/28007 [00:00<00:00, 259887.95it/s]
```

In [ ]:

```
preprocessed_question_body_input = Input(shape=(max_length,), name = "preprocessed_questior
emb = Embedding(vocab_size, 300, weights=[embedding_matrix], input_length=max_length,traina

lstm= LSTM(128,return_sequences=True)(emb)
dropoutlstm = Dropout(0.2)(lstm)
flat_question= Flatten()(dropoutlstm)
```

In [ ]:

```
from keras.preprocessing.text import Tokenizer
t = Tokenizer()
t.fit_on_texts(final_dataset['preprocessed_answer_body'])
vocab_size = len(t.word_index) + 1
```

In [ ]:

```
embedding_matrix = np.zeros((vocab_size, 300))
for word, i in tqdm(t.word_index.items()):
    embedding_vector = embeddings_index.get(word)
    if embedding_vector is not None:
        embedding_matrix[i] = embedding_vector
```

```
100%|██████████| 37594/37594 [00:00<00:00, 269170.12it/s]
```

In [ ]:

```
preprocessed_question_answer_input = Input(shape=(max_length,), name = "preprocessed_answer
emb = Embedding(vocab_size, 300, weights=[embedding_matrix], input_length=max_length,traina
lstm= LSTM(128,return_sequences=True)(emb)
dropoutlstm = Dropout(0.2)(lstm)
flat_answer= Flatten()(dropoutlstm)
```

In [ ]:

```
concat_layers = []
concat_layers.append(flat_title)
concat_layers.append(flat_question)
concat_layers.append(flat_answer)
concat_layers.append(category_flat)
concat_layers.append(host_flat)
concat_layers.append(num_field_dense)
```

In [ ]:

```
concat_layers = Concatenate()(concat_layers)
```

In [ ]:

```
concat_layers= Dense(512,activation='relu',kernel_initializer='he_normal',kernel_regularize
concat_layers = BatchNormalization()(concat_layers)
concat_layers= Dropout(0.4)(concat_layers)

# concat_layers= Dense(128,activation='relu',kernel_initializer='he_normal',kernel_regulari
# concat_layers = BatchNormalization()(concat_layers)
# concat_layers= Dropout(0.4)(concat_layers)

concat_layers= Dense(64,activation='relu',kernel_initializer='he_normal',kernel_regularizer
concat_layers = BatchNormalization()(concat_layers)

concat_layers= Dropout(0.4)(concat_layers)
concat_layers = BatchNormalization()(concat_layers)


output=Dense(len(target_columns), activation='sigmoid')(concat_layers)
model_2 = Model(inputs=[preprocessed_question_title_input,preprocessed_question_body_input,
```

In [ ]:

```
model_2.summary()
```

```
Model: "model_2"
____________________________________________________________________________
______________________
Layer (type)                    Output Shape         Param #     Connected t
o
============================================================================
======================
preprocessed_question_title (In (None, 600)          0

____________________________________________________________________________
______________________
embedding_3 (Embedding)         (None, 600, 300)     2176200     preprocesse
d_question_title[0][0]

____________________________________________________________________________
______________________
lstm_1 (LSTM)                   (None, 600, 128)     219648      embedding_3
[0][0]

____________________________________________________________________________
______________________
preprocessed_question_body (Inp (None, 600)          0

____________________________________________________________________________
______________________
preprocessed_answer_body (Input (None, 600)          0

____________________________________________________________________________
______________________
category (InputLayer)           (None, 5)            0

____________________________________________________________________________
______________________
host (InputLayer)               (None, 62)           0

____________________________________________________________________________
______________________
num_field_layer (InputLayer)    (None, 9)            0

____________________________________________________________________________
______________________
dropout_4 (Dropout)             (None, 600, 128)     0           lstm_1[0]
[0]

____________________________________________________________________________
______________________
embedding_4 (Embedding)         (None, 600, 300)     8402400     preprocesse
d_question_body[0][0]

____________________________________________________________________________
______________________
embedding_5 (Embedding)         (None, 600, 300)     11278500    preprocesse
d_answer_body[0][0]

____________________________________________________________________________
______________________
embedding_1 (Embedding)         (None, 5, 2)         10          category[0]
[0]

____________________________________________________________________________
______________________
embedding_2 (Embedding)         (None, 62, 2)        124         host[0][0]

____________________________________________________________________________
______________________
dense_1 (Dense)                 (None, 64)           640         num_field_l
ayer[0][0]

____________________________________________________________________________
______________________
flatten_3 (Flatten)             (None, 76800)        0           dropout_4
```

```
[0][0]
____________________________________________________________________________________________
flatten_4 (Flatten)             (None, 180000)       0           embedding_4
[0][0]
____________________________________________________________________________________________
flatten_5 (Flatten)             (None, 180000)       0           embedding_5
[0][0]
____________________________________________________________________________________________
flatten_1 (Flatten)             (None, 10)           0           embedding_1
[0][0]
____________________________________________________________________________________________
flatten_2 (Flatten)             (None, 124)          0           embedding_2
[0][0]
____________________________________________________________________________________________
dropout_1 (Dropout)             (None, 64)           0           dense_1[0]
[0]
____________________________________________________________________________________________
concatenate_2 (Concatenate)     (None, 436998)       0           flatten_3
[0][0]
                                                                 flatten_4
[0][0]
                                                                 flatten_5
[0][0]
                                                                 flatten_1
[0][0]
                                                                 flatten_2
[0][0]
                                                                 dropout_1
[0][0]
____________________________________________________________________________________________
dense_5 (Dense)                 (None, 512)          223743488   concatenate
_2[0][0]
____________________________________________________________________________________________
batch_normalization_4 (BatchNor (None, 512)          2048        dense_5[0]
[0]
____________________________________________________________________________________________
dropout_5 (Dropout)             (None, 512)          0           batch_norma
lization_4[0][0]
____________________________________________________________________________________________
dense_6 (Dense)                 (None, 64)           32832       dropout_5
[0][0]
____________________________________________________________________________________________
batch_normalization_5 (BatchNor (None, 64)           256         dense_6[0]
[0]
____________________________________________________________________________________________
dropout_6 (Dropout)             (None, 64)           0           batch_norma
lization_5[0][0]
____________________________________________________________________________________________
```

```
batch_normalization_6 (BatchNor (None, 64)           256         dropout_6
[0][0]
____________________________________________________________________________
______________________
dense_7 (Dense)                 (None, 30)           1950        batch_norma
lization_6[0][0]
============================================================================
======================
Total params: 245,858,352
Trainable params: 223,999,972
Non-trainable params: 21,858,380
____________________________________________________________________________
______________________
```

In [ ]:

```
X_train = [padded_docs_train_question_title,padded_docs_train_question_body,padded_docs_tra
x_cv = [padded_docs_cv_question_title,padded_docs_cv_question_body,padded_docs_cv_question_
```

In [ ]:

```
model_2.compile(optimizer='adam', loss='binary_crossentropy',metrics=['mse', 'mae'])
```

In [ ]:

```
history_2 = model_2.fit(X_train,y_train,epochs=60,batch_size=400,verbose=1, validation_data
```

```
Train on 5471 samples, validate on 608 samples
Epoch 1/60
5471/5471 [==============================] - 117s 21ms/step - loss: 2.4678
- mse: 0.1911 - mae: 0.3829 - val_loss: 2.6868 - val_mse: 0.2434 - val_ma
e: 0.4312
Epoch 2/60
5471/5471 [==============================] - 110s 20ms/step - loss: 1.9941
- mse: 0.1744 - mae: 0.3685 - val_loss: 1.4977 - val_mse: 0.1844 - val_ma
e: 0.3817
Epoch 3/60
5471/5471 [==============================] - 109s 20ms/step - loss: 1.2258
- mse: 0.1645 - mae: 0.3582 - val_loss: 1.0095 - val_mse: 0.1578 - val_ma
e: 0.3602
Epoch 4/60
5471/5471 [==============================] - 109s 20ms/step - loss: 0.9382
- mse: 0.1522 - mae: 0.3443 - val_loss: 0.8574 - val_mse: 0.1417 - val_ma
e: 0.3430
Epoch 5/60
5471/5471 [==============================] - 109s 20ms/step - loss: 0.8531
```

In [ ]:

```
valid_preds = []
valid_preds.append(model_2.predict(x_cv))
```

In [ ]:

```
spear_val = compute_spearmanr_ignore_nan(y_cv, valid_preds[-1])
print('validation score = ', spear_val)
```

```
validation score =  0.30347783279562524
```

Deep Learning Model Convolution Neural Network(CNN)

In [ ]:

```
from keras.preprocessing.text import Tokenizer
t = Tokenizer()
t.fit_on_texts(final_dataset['preprocessed_question_title'])
vocab_size = len(t.word_index) + 1
```

In [ ]:

```
embedding_matrix = np.zeros((vocab_size, 300))
for word, i in tqdm(t.word_index.items()):
    embedding_vector = embeddings_index.get(word)
    if embedding_vector is not None:
        embedding_matrix[i] = embedding_vector
```

```
100%|██████████| 7253/7253 [00:00<00:00, 57611.60it/s]
```

In [ ]:

```
print(embedding_matrix.shape)
```

```
(7254, 300)
```

In [ ]:

```
from keras.layers.convolutional import Conv1D
from keras.layers.convolutional import MaxPooling1D
preprocessed_question_title_input = Input(shape=(max_length,), name = "preprocessed_questic
emb = Embedding(vocab_size, 300, weights=[embedding_matrix], input_length=max_length,traina
conv1 = Conv1D(filters=32, kernel_size=4, activation='relu')(emb)
pool1 = MaxPooling1D(pool_size=2)(conv1)
dropoutcnv = Dropout(0.2)(pool1)
flat_title= Flatten()(dropoutcnv)
```

In [ ]:

```
from keras.preprocessing.text import Tokenizer
t = Tokenizer()
t.fit_on_texts(final_dataset['preprocessed_question_body'])
vocab_size = len(t.word_index) + 1
```

In [ ]:

```
embedding_matrix = np.zeros((vocab_size, 300))
for word, i in tqdm(t.word_index.items()):
    embedding_vector = embeddings_index.get(word)
    if embedding_vector is not None:
        embedding_matrix[i] = embedding_vector
```

```
100%|██████████| 28007/28007 [00:00<00:00, 99720.18it/s]
```

In [ ]:

```
preprocessed_question_body_input = Input(shape=(max_length,), name = "preprocessed_questior
emb = Embedding(vocab_size, 300, weights=[embedding_matrix], input_length=max_length,traina

flat_question= Flatten()(emb)
```

In [ ]:

```
from keras.preprocessing.text import Tokenizer
t = Tokenizer()
t.fit_on_texts(final_dataset['preprocessed_answer_body'])
vocab_size = len(t.word_index) + 1
```

In [ ]:

```
embedding_matrix = np.zeros((vocab_size, 300))
for word, i in tqdm(t.word_index.items()):
    embedding_vector = embeddings_index.get(word)
    if embedding_vector is not None:
        embedding_matrix[i] = embedding_vector
```

```
100%|██████████| 37594/37594 [00:00<00:00, 156220.63it/s]
```

In [ ]:

```
preprocessed_question_answer_input = Input(shape=(max_length,), name = "preprocessed_answer
emb = Embedding(vocab_size, 300, weights=[embedding_matrix], input_length=max_length,traina

flat_answer= Flatten()(emb)
```

In [ ]:

```
concat_layers = []
concat_layers.append(flat_title)
concat_layers.append(flat_question)
concat_layers.append(flat_answer)
concat_layers.append(category_flat)
concat_layers.append(host_flat)
concat_layers.append(num_field_dense)
```

In [ ]:

```
concat_layers = Concatenate()(concat_layers)
```

In [ ]:

```
concat_layers= Dense(512,activation='relu',kernel_initializer='he_normal',kernel_regularize
concat_layers = BatchNormalization()(concat_layers)
concat_layers= Dropout(0.4)(concat_layers)

# concat_layers= Dense(128,activation='relu',kernel_initializer='he_normal',kernel_regulari
# concat_layers = BatchNormalization()(concat_layers)
# concat_layers= Dropout(0.4)(concat_layers)

concat_layers= Dense(64,activation='relu',kernel_initializer='he_normal',kernel_regularizer
concat_layers = BatchNormalization()(concat_layers)

concat_layers= Dropout(0.4)(concat_layers)
concat_layers = BatchNormalization()(concat_layers)


output=Dense(len(target_columns), activation='sigmoid')(concat_layers)
model_3 = Model(inputs=[preprocessed_question_title_input,preprocessed_question_body_input,
```

In [ ]:

```
model_3.summary()
```

```
Model: "model_3"
____________________________________________________________________________
______________________
Layer (type)                    Output Shape         Param #     Connected t
o
============================================================================
======================
preprocessed_question_title (In (None, 600)          0
____________________________________________________________________________
______________________
embedding_6 (Embedding)         (None, 600, 300)     2176200     preprocesse
d_question_title[0][0]
____________________________________________________________________________
______________________
conv1d_1 (Conv1D)               (None, 597, 32)      38432       embedding_6
[0][0]
____________________________________________________________________________
______________________
max_pooling1d_1 (MaxPooling1D)  (None, 298, 32)      0           conv1d_1[0]
[0]
____________________________________________________________________________
______________________
preprocessed_question_body (Inp (None, 600)          0
____________________________________________________________________________
______________________
preprocessed_answer_body (Input (None, 600)          0
____________________________________________________________________________
______________________
category (InputLayer)           (None, 5)            0
____________________________________________________________________________
______________________
host (InputLayer)               (None, 62)           0
____________________________________________________________________________
______________________
num_field_layer (InputLayer)    (None, 9)            0
____________________________________________________________________________
______________________
dropout_7 (Dropout)             (None, 298, 32)      0           max_pooling
1d_1[0][0]
____________________________________________________________________________
______________________
embedding_7 (Embedding)         (None, 600, 300)     8402400     preprocesse
d_question_body[0][0]
____________________________________________________________________________
______________________
embedding_8 (Embedding)         (None, 600, 300)     11278500    preprocesse
d_answer_body[0][0]
____________________________________________________________________________
______________________
embedding_1 (Embedding)         (None, 5, 2)         10          category[0]
[0]
____________________________________________________________________________
______________________
embedding_2 (Embedding)         (None, 62, 2)        124         host[0][0]
____________________________________________________________________________
______________________
dense_1 (Dense)                 (None, 64)           640         num_field_l
```

```
ayer[0][0]
__________________________________________________________________________________________________
flatten_6 (Flatten)             (None, 9536)         0           dropout_7
[0][0]
__________________________________________________________________________________________________
flatten_7 (Flatten)             (None, 180000)       0           embedding_7
[0][0]
__________________________________________________________________________________________________
flatten_8 (Flatten)             (None, 180000)       0           embedding_8
[0][0]
__________________________________________________________________________________________________
flatten_1 (Flatten)             (None, 10)           0           embedding_1
[0][0]
__________________________________________________________________________________________________
flatten_2 (Flatten)             (None, 124)          0           embedding_2
[0][0]
__________________________________________________________________________________________________
dropout_1 (Dropout)             (None, 64)           0           dense_1[0]
[0]
__________________________________________________________________________________________________
concatenate_3 (Concatenate)     (None, 369734)       0           flatten_6
[0][0]
                                                                 flatten_7
[0][0]
                                                                 flatten_8
[0][0]
                                                                 flatten_1
[0][0]
                                                                 flatten_2
[0][0]
                                                                 dropout_1
[0][0]
__________________________________________________________________________________________________
dense_8 (Dense)                 (None, 512)          189304320   concatenate
_3[0][0]
__________________________________________________________________________________________________
batch_normalization_7 (BatchNor (None, 512)          2048        dense_8[0]
[0]
__________________________________________________________________________________________________
dropout_8 (Dropout)             (None, 512)          0           batch_norma
lization_7[0][0]
__________________________________________________________________________________________________
dense_9 (Dense)                 (None, 64)           32832       dropout_8
[0][0]
__________________________________________________________________________________________________
batch_normalization_8 (BatchNor (None, 64)           256         dense_9[0]
[0]
__________________________________________________________________________________________________
```

```
dropout_9 (Dropout)             (None, 64)           0           batch_norma
lization_8[0][0]
____________________________________________________________________________
______________________
batch_normalization_9 (BatchNor (None, 64)           256         dropout_9
[0][0]
____________________________________________________________________________
______________________
dense_10 (Dense)                (None, 30)           1950        batch_norma
lization_9[0][0]
============================================================================
======================
Total params: 211,237,968
Trainable params: 189,379,588
Non-trainable params: 21,858,380
____________________________________________________________________________
______________________
```

In [ ]:

```
X_train = [padded_docs_train_question_title,padded_docs_train_question_body,padded_docs_tra
x_cv = [padded_docs_cv_question_title,padded_docs_cv_question_body,padded_docs_cv_question_
```

In [ ]:

```
model_3.compile(optimizer='adam', loss='binary_crossentropy',metrics=['mse', 'mae'])
```

In [ ]:

```
history_3 = model_3.fit(X_train,y_train,epochs=60,batch_size=400,verbose=1, validation_data
```

```
Train on 5471 samples, validate on 608 samples
Epoch 1/60
5471/5471 [==============================] - 63s 12ms/step - loss: 2.4398
- mse: 0.1896 - mae: 0.3835 - val_loss: 2.4587 - val_mse: 0.1869 - val_ma
e: 0.3742
Epoch 2/60
5471/5471 [==============================] - 59s 11ms/step - loss: 1.9084
- mse: 0.1723 - mae: 0.3683 - val_loss: 1.3865 - val_mse: 0.1622 - val_ma
e: 0.3588
Epoch 3/60
5471/5471 [==============================] - 59s 11ms/step - loss: 1.1764
- mse: 0.1627 - mae: 0.3580 - val_loss: 0.9696 - val_mse: 0.1508 - val_ma
e: 0.3534
Epoch 4/60
5471/5471 [==============================] - 59s 11ms/step - loss: 0.9256
- mse: 0.1511 - mae: 0.3443 - val_loss: 0.8580 - val_mse: 0.1417 - val_ma
e: 0.3440
Epoch 5/60
5471/5471 [==============================] - 59s 11ms/step - loss: 0.8507
```

In [ ]:

```
valid_preds = []
valid_preds.append(model_3.predict(x_cv))
```

In [ ]:

```
spear_val = compute_spearmanr_ignore_nan(y_cv, valid_preds[-1])
print('validation score = ', spear_val)
```

```
validation score =  0.314084055659804
```

Deep Learning Model Mxied LSTM and Convolution Neural Network(CNN)

In [ ]:

```
from keras.preprocessing.text import Tokenizer
t = Tokenizer()
t.fit_on_texts(final_dataset['preprocessed_question_title'])
vocab_size = len(t.word_index) + 1
```

In [ ]:

```
embedding_matrix = np.zeros((vocab_size, 300))
for word, i in tqdm(t.word_index.items()):
    embedding_vector = embeddings_index.get(word)
    if embedding_vector is not None:
        embedding_matrix[i] = embedding_vector
```

```
100%|██████████| 7253/7253 [00:00<00:00, 107059.15it/s]
```

In [ ]:

```
print(embedding_matrix.shape)
```

```
(7254, 300)
```

In [ ]:

```
from keras.layers.convolutional import Conv1D
from keras.layers.convolutional import MaxPooling1D
preprocessed_question_title_input = Input(shape=(max_length,), name = "preprocessed_questic
emb = Embedding(vocab_size, 300, weights=[embedding_matrix], input_length=max_length,traina
conv1 = Conv1D(filters=32, kernel_size=4, activation='relu')(emb)
pool1 = MaxPooling1D(pool_size=2)(conv1)
lstm_CNN= LSTM(128,return_sequences=True)(pool1)
dropout_CNN_LSTM = Dropout(0.2)(lstm_CNN)
flat_title = Flatten()(dropout_CNN_LSTM)
```

In [ ]:

```
from keras.preprocessing.text import Tokenizer
t = Tokenizer()
t.fit_on_texts(final_dataset['preprocessed_question_body'])
vocab_size = len(t.word_index) + 1
```

In [ ]:

```
embedding_matrix = np.zeros((vocab_size, 300))
for word, i in tqdm(t.word_index.items()):
    embedding_vector = embeddings_index.get(word)
    if embedding_vector is not None:
        embedding_matrix[i] = embedding_vector
```

```
100%|██████████| 28007/28007 [00:00<00:00, 149749.79it/s]
```

In [ ]:

```
preprocessed_question_body_input = Input(shape=(max_length,), name = "preprocessed_questior
emb = Embedding(vocab_size, 300, weights=[embedding_matrix], input_length=max_length,traina

flat_question= Flatten()(emb)
```

In [ ]:

```
from keras.preprocessing.text import Tokenizer
t = Tokenizer()
t.fit_on_texts(final_dataset['preprocessed_answer_body'])
vocab_size = len(t.word_index) + 1
```

In [ ]:

```
embedding_matrix = np.zeros((vocab_size, 300))
for word, i in tqdm(t.word_index.items()):
    embedding_vector = embeddings_index.get(word)
    if embedding_vector is not None:
        embedding_matrix[i] = embedding_vector
```

```
100%|██████████| 37594/37594 [00:00<00:00, 212690.23it/s]
```

In [ ]:

```
preprocessed_question_answer_input = Input(shape=(max_length,), name = "preprocessed_answer
emb = Embedding(vocab_size, 300, weights=[embedding_matrix], input_length=max_length,traina

flat_answer= Flatten()(emb)
```

In [ ]:

```
concat_layers = []
concat_layers.append(flat_title)
concat_layers.append(flat_question)
concat_layers.append(flat_answer)
concat_layers.append(category_flat)
concat_layers.append(host_flat)
concat_layers.append(num_field_dense)
```

In [ ]:

```
concat_layers = Concatenate()(concat_layers)
```

In [ ]:

```
concat_layers= Dense(512,activation='relu',kernel_initializer='he_normal',kernel_regularize
concat_layers = BatchNormalization()(concat_layers)
concat_layers= Dropout(0.4)(concat_layers)

# concat_layers= Dense(128,activation='relu',kernel_initializer='he_normal',kernel_regulari
# concat_layers = BatchNormalization()(concat_layers)
# concat_layers= Dropout(0.4)(concat_layers)

concat_layers= Dense(64,activation='relu',kernel_initializer='he_normal',kernel_regularizer
concat_layers = BatchNormalization()(concat_layers)

concat_layers= Dropout(0.4)(concat_layers)
concat_layers = BatchNormalization()(concat_layers)


output=Dense(len(target_columns), activation='sigmoid')(concat_layers)
model_4 = Model(inputs=[preprocessed_question_title_input,preprocessed_question_body_input,
```

In [ ]:

```
model_4.summary()
```

```
Model: "model_4"
____________________________________________________________________________
______________________
Layer (type)                    Output Shape         Param #     Connected t
o
============================================================================
======================
preprocessed_question_title (In (None, 600)          0
____________________________________________________________________________
______________________
embedding_9 (Embedding)         (None, 600, 300)     2176200     preprocesse
d_question_title[0][0]
____________________________________________________________________________
______________________
conv1d_2 (Conv1D)               (None, 597, 32)      38432       embedding_9
[0][0]
____________________________________________________________________________
______________________
max_pooling1d_2 (MaxPooling1D)  (None, 298, 32)      0           conv1d_2[0]
[0]
____________________________________________________________________________
______________________
lstm_2 (LSTM)                   (None, 298, 128)     82432       max_pooling
1d_2[0][0]
____________________________________________________________________________
______________________
preprocessed_question_body (Inp (None, 600)          0
____________________________________________________________________________
______________________
preprocessed_answer_body (Input (None, 600)          0
____________________________________________________________________________
______________________
category (InputLayer)           (None, 5)            0
____________________________________________________________________________
______________________
host (InputLayer)               (None, 62)           0
____________________________________________________________________________
______________________
num_field_layer (InputLayer)    (None, 9)            0
____________________________________________________________________________
______________________
dropout_10 (Dropout)            (None, 298, 128)     0           lstm_2[0]
[0]
____________________________________________________________________________
______________________
embedding_10 (Embedding)        (None, 600, 300)     8402400     preprocesse
d_question_body[0][0]
____________________________________________________________________________
______________________
embedding_11 (Embedding)        (None, 600, 300)     11278500    preprocesse
d_answer_body[0][0]
____________________________________________________________________________
______________________
embedding_1 (Embedding)         (None, 5, 2)         10          category[0]
[0]
____________________________________________________________________________
______________________
```

```
embedding_2 (Embedding)         (None, 62, 2)        124         host[0][0]
____________________________________________________________________________
______________________
dense_1 (Dense)                 (None, 64)           640         num_field_l
ayer[0][0]
____________________________________________________________________________
______________________
flatten_9 (Flatten)             (None, 38144)        0           dropout_10
[0][0]
____________________________________________________________________________
______________________
flatten_10 (Flatten)            (None, 180000)       0           embedding_1
0[0][0]
____________________________________________________________________________
______________________
flatten_11 (Flatten)            (None, 180000)       0           embedding_1
1[0][0]
____________________________________________________________________________
______________________
flatten_1 (Flatten)             (None, 10)           0           embedding_1
[0][0]
____________________________________________________________________________
______________________
flatten_2 (Flatten)             (None, 124)          0           embedding_2
[0][0]
____________________________________________________________________________
______________________
dropout_1 (Dropout)             (None, 64)           0           dense_1[0]
[0]
____________________________________________________________________________
______________________
concatenate_4 (Concatenate)     (None, 398342)       0           flatten_9
[0][0]
                                                                 flatten_10
[0][0]
                                                                 flatten_11
[0][0]
                                                                 flatten_1
[0][0]
                                                                 flatten_2
[0][0]
                                                                 dropout_1
[0][0]
____________________________________________________________________________
______________________
dense_11 (Dense)                (None, 512)          203951616   concatenate
_4[0][0]
____________________________________________________________________________
______________________
batch_normalization_10 (BatchNo (None, 512)          2048        dense_11[0]
[0]
____________________________________________________________________________
______________________
dropout_11 (Dropout)            (None, 512)          0           batch_norma
lization_10[0][0]
____________________________________________________________________________
______________________
dense_12 (Dense)                (None, 64)           32832       dropout_11
[0][0]
____________________________________________________________________________
______________________
```

```
batch_normalization_11 (BatchNo (None, 64)           256         dense_12[0]
[0]
____________________________________________________________________________
______________________
dropout_12 (Dropout)            (None, 64)           0           batch_norma
lization_11[0][0]
____________________________________________________________________________
______________________
batch_normalization_12 (BatchNo (None, 64)           256         dropout_12
[0][0]
____________________________________________________________________________
______________________
dense_13 (Dense)                (None, 30)           1950        batch_norma
lization_12[0][0]
============================================================================
======================
Total params: 225,967,696
Trainable params: 204,109,316
Non-trainable params: 21,858,380
____________________________________________________________________________
______________________
```

In [ ]:

```
X_train = [padded_docs_train_question_title,padded_docs_train_question_body,padded_docs_tra
x_cv = [padded_docs_cv_question_title,padded_docs_cv_question_body,padded_docs_cv_question_
```

In [ ]:

```
model_4.compile(optimizer='adam', loss='binary_crossentropy',metrics=['mse', 'mae'])
```

In [ ]:

```
history_4 = model_4.fit(X_train,y_train,epochs=60,batch_size=400,verbose=1, validation_data
```

```
Train on 5471 samples, validate on 608 samples
Epoch 1/60
5471/5471 [==============================] - 87s 16ms/step - loss: 2.2553
- mse: 0.1927 - mae: 0.3846 - val_loss: 2.3754 - val_mse: 0.2038 - val_ma
e: 0.3939
Epoch 2/60
5471/5471 [==============================] - 81s 15ms/step - loss: 1.8755
- mse: 0.1743 - mae: 0.3681 - val_loss: 1.4286 - val_mse: 0.1751 - val_ma
e: 0.3746
Epoch 3/60
5471/5471 [==============================] - 81s 15ms/step - loss: 1.1906
- mse: 0.1637 - mae: 0.3571 - val_loss: 0.9742 - val_mse: 0.1506 - val_ma
e: 0.3527
Epoch 4/60
5471/5471 [==============================] - 81s 15ms/step - loss: 0.9242
- mse: 0.1516 - mae: 0.3431 - val_loss: 0.8439 - val_mse: 0.1404 - val_ma
e: 0.3409
Epoch 5/60
5471/5471 [==============================] - 82s 15ms/step - loss: 0.8341
```

In [ ]:

```
valid_preds = []
valid_preds.append(model_4.predict(x_cv))
```

In [ ]:

```
spear_val = compute_spearmanr_ignore_nan(y_cv, valid_preds[-1])
print('validation score = ', spear_val)
```

```
validation score =  0.2937666928755609
```

Natural language Processing Bert ,XLNET ,Roberta

In [ ]:

```
! pip install transformers
```

```
Requirement already satisfied: transformers in /usr/local/lib/python3.6/dist
-packages (2.11.0)
Requirement already satisfied: sentencepiece in /usr/local/lib/python3.6/dis
t-packages (from transformers) (0.1.91)
Requirement already satisfied: numpy in /usr/local/lib/python3.6/dist-packag
es (from transformers) (1.18.5)
Requirement already satisfied: dataclasses; python_version < "3.7" in /usr/l
ocal/lib/python3.6/dist-packages (from transformers) (0.7)
Requirement already satisfied: filelock in /usr/local/lib/python3.6/dist-pac
kages (from transformers) (3.0.12)
Requirement already satisfied: regex!=2019.12.17 in /usr/local/lib/python3.
6/dist-packages (from transformers) (2019.12.20)
Requirement already satisfied: packaging in /usr/local/lib/python3.6/dist-pa
ckages (from transformers) (20.4)
Requirement already satisfied: tokenizers==0.7.0 in /usr/local/lib/python3.
6/dist-packages (from transformers) (0.7.0)
Requirement already satisfied: sacremoses in /usr/local/lib/python3.6/dist-p
ackages (from transformers) (0.0.43)
Requirement already satisfied: requests in /usr/local/lib/python3.6/dist-pac
kages (from transformers) (2.23.0)
Requirement already satisfied: tqdm>=4.27 in /usr/local/lib/python3.6/dist-p
ackages (from transformers) (4.41.1)
Requirement already satisfied: pyparsing>=2.0.2 in /usr/local/lib/python3.6/
dist-packages (from packaging->transformers) (2.4.7)
Requirement already satisfied: six in /usr/local/lib/python3.6/dist-packages
(from packaging->transformers) (1.12.0)
Requirement already satisfied: click in /usr/local/lib/python3.6/dist-packag
es (from sacremoses->transformers) (7.1.2)
Requirement already satisfied: joblib in /usr/local/lib/python3.6/dist-packa
ges (from sacremoses->transformers) (0.15.1)
Requirement already satisfied: certifi>=2017.4.17 in /usr/local/lib/python3.
6/dist-packages (from requests->transformers) (2020.4.5.2)
Requirement already satisfied: urllib3!=1.25.0,!=1.25.1,<1.26,>=1.21.1 in /u
sr/local/lib/python3.6/dist-packages (from requests->transformers) (1.24.3)
Requirement already satisfied: chardet<4,>=3.0.2 in /usr/local/lib/python3.
6/dist-packages (from requests->transformers) (3.0.4)
Requirement already satisfied: idna<3,>=2.5 in /usr/local/lib/python3.6/dist
-packages (from requests->transformers) (2.9)
```

In [3]:

```
from google.colab import drive
drive.mount('/content/drive')
```

```
Go to this URL in a browser: https://accounts.google.com/o/oauth2/auth?clien
t_id=947318989803-6bn6qk8qdgf4n4g3pfee6491hc0brc4i.apps.googleusercontent.co
m&redirect_uri=urn%3aietf%3awg%3aoauth%3a2.0%3aoob&response_type=code&scope=
email%20https%3a%2f%2fwww.googleapis.com%2fauth%2fdocs.test%20https%3a%2f%2f
www.googleapis.com%2fauth%2fdrive%20https%3a%2f%2fwww.googleapis.com%2fauth%
2fdrive.photos.readonly%20https%3a%2f%2fwww.googleapis.com%2fauth%2fpeopleap
i.readonly (https://accounts.google.com/o/oauth2/auth?client_id=947318989803
-6bn6qk8qdgf4n4g3pfee6491hc0brc4i.apps.googleusercontent.com&redirect_uri=ur
n%3aietf%3awg%3aoauth%3a2.0%3aoob&response_type=code&scope=email%20https%3a%
2f%2fwww.googleapis.com%2fauth%2fdocs.test%20https%3a%2f%2fwww.googleapis.co
m%2fauth%2fdrive%20https%3a%2f%2fwww.googleapis.com%2fauth%2fdrive.photos.re
adonly%20https%3a%2f%2fwww.googleapis.com%2fauth%2fpeopleapi.readonly)

Enter your authorization code:
··········
Mounted at /content/drive
```

In [ ]:

```
print('Reading data...')
train_data = pd.read_csv('/content/drive/My Drive/Google/train.csv')
test_data = pd.read_csv('/content/drive/My Drive/Google/test.csv')
sample_submission = pd.read_csv('/content/drive/My Drive/Google/sample_submission.csv')
print('Reading data completed')
```

```
Reading data...
Reading data completed
```

In [ ]:

```
target_columns = list(sample_submission.columns)[1:]
```

In [ ]:

```
print(len(target_columns))
print(target_columns)
```

```
30
['question_asker_intent_understanding', 'question_body_critical', 'question_
conversational', 'question_expect_short_answer', 'question_fact_seeking', 'q
uestion_has_commonly_accepted_answer', 'question_interestingness_others', 'q
uestion_interestingness_self', 'question_multi_intent', 'question_not_really
_a_question', 'question_opinion_seeking', 'question_type_choice', 'question_
type_compare', 'question_type_consequence', 'question_type_definition', 'que
stion_type_entity', 'question_type_instructions', 'question_type_procedure',
'question_type_reason_explanation', 'question_type_spelling', 'question_well
_written', 'answer_helpful', 'answer_level_of_information', 'answer_plausibl
e', 'answer_relevance', 'answer_satisfaction', 'answer_type_instructions',
'answer_type_procedure', 'answer_type_reason_explanation', 'answer_well_writ
ten']
```

In [ ]:

```
final_dataset = train_data.drop(target_columns, axis=1)
final_dataset_target = train_data[target_columns].copy()
```

In [ ]:

```
print(final_dataset.shape)
print(final_dataset_target.shape)
```

```
(6079, 11)
(6079, 30)
```

In [ ]:

```
model_name = 'bert-base-uncased'
tokenizer = BertTokenizer.from_pretrained('bert-base-uncased',additional_special_tokens=['<
MAX_SEQUENCE_LENGTH = 512
```

```
HBox(children=(FloatProgress(value=0.0, description='Downloading', max=23150
8.0, style=ProgressStyle(descripti…
```

In [ ]:

```
## The function to creat the masks using to the title, question and answer
def convert_to_Bert_inputs(title, question, answer, tokenizer, max_sequence_length):
    """Converts tokenized input to ids, masks and segments for transformer (including bert)

    def return_bert_ids(str1, str2, truncation_strategy, length):

        inputs = tokenizer.encode_plus(str1, str2,add_special_tokens=True,max_length=length

        input_ids =  inputs["input_ids"]
        input_segments = inputs["token_type_ids"]
        input_masks = inputs["attention_mask"]
        return [input_ids, input_masks, input_segments]

    input_ids_question, input_masks_question, input_segments_question = return_bert_ids(
        title + ' ' + question, None, 'longest_first', max_sequence_length)

    input_ids_answer, input_masks_answer, input_segments_answer = return_bert_ids(
        answer, None, 'longest_first', max_sequence_length)

    return [input_ids_question, input_masks_question, input_segments_question,
            input_ids_answer, input_masks_answer, input_segments_answer]
```

In [ ]:

```
# Computing the inputs
def compute_input_Bert(df, columns, tokenizer, max_sequence_length):

    input_ids_question, input_masks_question, input_segments_question = [], [], []
    input_ids_answer, input_masks_answer, input_segments_answer = [], [], []

    for indexes, series_data in tqdm(df[columns].iterrows()):

        t, q, a = series_data.question_title, series_data.question_body, series_data.answer

        ids_q, masks_q, segments_q, ids_a, masks_a, segments_a = convert_to_Bert_inputs(t,

        input_ids_question.append(ids_q)
        input_masks_question.append(masks_q)
        input_segments_question.append(segments_q)

        input_ids_answer.append(ids_a)
        input_masks_answer.append(masks_a)
        input_segments_answer.append(segments_a)

    return [np.asarray(input_ids_question, dtype=np.int32),
            np.asarray(input_masks_question, dtype=np.int32),
            np.asarray(input_segments_question, dtype=np.int32),
            np.asarray(input_ids_answer, dtype=np.int32),
            np.asarray(input_masks_answer, dtype=np.int32),
            np.asarray(input_segments_answer, dtype=np.int32)]
```

In [ ]:

```
## Computing the error metric to the model optimization
def compute_spearmanr_ignore_nan(trues, preds):
    rhos = []
    for tcol, pcol in zip(np.transpose(trues), np.transpose(preds)):
        rhos.append(spearmanr(tcol, pcol).correlation)
    return np.nanmean(rhos)
```

In [ ]:

```
def create_model(model_name):

    config = BertConfig()
    config.output_hidden_states = False

    question_bert_model = TFBertModel.from_pretrained(model_name, config=config)
    answer_bert_model = TFBertModel.from_pretrained(model_name, config=config)


    question_enc = tf.keras.layers.Input((MAX_SEQUENCE_LENGTH,), dtype=tf.int32)
    question_mask = tf.keras.layers.Input((MAX_SEQUENCE_LENGTH,), dtype=tf.int32)
    question_type_ids = tf.keras.layers.Input((MAX_SEQUENCE_LENGTH,), dtype=tf.int32)

    answer_enc = tf.keras.layers.Input((MAX_SEQUENCE_LENGTH,), dtype=tf.int32)
    answer_mask = tf.keras.layers.Input((MAX_SEQUENCE_LENGTH,), dtype=tf.int32)
    answer_type_ids = tf.keras.layers.Input((MAX_SEQUENCE_LENGTH,), dtype=tf.int32)

    question_bert = question_bert_model(question_enc, attention_mask=question_mask, token_t
    answer_bert = answer_bert_model(answer_enc, attention_mask=answer_mask, token_type_ids=

    question_bert_summary = tf.keras.layers.Flatten()(tf.keras.layers.AveragePooling1D(MAX_
    answer_bert_summary = tf.keras.layers.Flatten()(tf.keras.layers.AveragePooling1D(MAX_SE

    combined_bert_summary = tf.keras.layers.Concatenate()([question_bert_summary, answer_be
    dropout_bert = tf.keras.layers.Dropout(0.2)(combined_bert_summary)
    output = tf.keras.layers.Dense(30, activation='sigmoid')(dropout_bert)
    model = tf.keras.models.Model(inputs=[question_enc, question_mask, question_type_ids, a

    return model
```

In [ ]:

```
def compute_output_arrays(df, columns):
    return np.asarray(df[columns])
```

In [ ]:

```
final_dataset_target.shape
```

Out[17]:

```
(6079, 30)
```

In [ ]:

```
inputs = compute_input_Bert(final_dataset, final_dataset.columns, tokenizer, MAX_SEQUENCE_L
outputs = compute_output_arrays(final_dataset_target, final_dataset_target.columns)
```

```
6079it [00:38, 158.30it/s]
```

In [ ]:

```
cvFold = GroupKFold(n_splits=5).split(X=final_dataset.question_body, groups=final_dataset.q

## to receive predictions
valid_preds = []

## Looping throught the folds
for fold, (train_idx, valid_idx) in enumerate(cvFold):


        ## Train index from Kfold
        train_inputs = [inputs[i][train_idx] for i in range(len(inputs))]
        train_outputs = outputs[train_idx]
        ## Valid index from Kfold
        valid_inputs = [inputs[i][valid_idx] for i in range(len(inputs))]
        valid_outputs = outputs[valid_idx]

        K.clear_session()

        ## Instantiating the Bert Model
        model = create_model(model_name)
        optimizer = tf.keras.optimizers.Adam(learning_rate=2e-5)
        model.compile(loss='binary_crossentropy', optimizer=optimizer)
        ## Fiting the model
        model.fit(train_inputs, train_outputs, epochs=2, batch_size=3)

        valid_preds.append(model.predict(valid_inputs))

        # Calculating the error in the valid set
        rho_val = compute_spearmanr_ignore_nan(valid_outputs, valid_preds[-1])
        print('validation score = ', rho_val)
```

```
HBox(children=(FloatProgress(value=0.0, description='Downloading', max=53606
3208.0, style=ProgressStyle(descri…


Epoch 1/2
WARNING:tensorflow:Gradients do not exist for variables ['tf_bert_model/be
rt/pooler/dense/kernel:0', 'tf_bert_model/bert/pooler/dense/bias:0', 'tf_b
ert_model_1/bert/pooler/dense/kernel:0', 'tf_bert_model_1/bert/pooler/dens
e/bias:0'] when minimizing the loss.
WARNING:tensorflow:Gradients do not exist for variables ['tf_bert_model/be
rt/pooler/dense/kernel:0', 'tf_bert_model/bert/pooler/dense/bias:0', 'tf_b
ert_model_1/bert/pooler/dense/kernel:0', 'tf_bert_model_1/bert/pooler/dens
e/bias:0'] when minimizing the loss.
WARNING:tensorflow:Gradients do not exist for variables ['tf_bert_model/be
rt/pooler/dense/kernel:0', 'tf_bert_model/bert/pooler/dense/bias:0', 'tf_b
ert_model_1/bert/pooler/dense/kernel:0', 'tf_bert_model_1/bert/pooler/dens
e/bias:0'] when minimizing the loss.
WARNING:tensorflow:Gradients do not exist for variables ['tf_bert_model/be
rt/pooler/dense/kernel:0', 'tf_bert_model/bert/pooler/dense/bias:0', 'tf_b
ert_model_1/bert/pooler/dense/kernel:0', 'tf_bert_model_1/bert/pooler/dens
e/bias:0'] when minimizing the loss.
1621/1621 [==============================] - 724s 447ms/step - loss: 0.390
2
Epoch 2/2
1621/1621 [==============================] - 724s 447ms/step - loss: 0.361
8
validation score =  0.3946677940168535
```

```
Epoch 1/2
WARNING:tensorflow:Gradients do not exist for variables ['tf_bert_model/be
rt/pooler/dense/kernel:0', 'tf_bert_model/bert/pooler/dense/bias:0', 'tf_b
ert_model_1/bert/pooler/dense/kernel:0', 'tf_bert_model_1/bert/pooler/dens
e/bias:0'] when minimizing the loss.
WARNING:tensorflow:Gradients do not exist for variables ['tf_bert_model/be
rt/pooler/dense/kernel:0', 'tf_bert_model/bert/pooler/dense/bias:0', 'tf_b
ert_model_1/bert/pooler/dense/kernel:0', 'tf_bert_model_1/bert/pooler/dens
e/bias:0'] when minimizing the loss.
WARNING:tensorflow:Gradients do not exist for variables ['tf_bert_model/be
rt/pooler/dense/kernel:0', 'tf_bert_model/bert/pooler/dense/bias:0', 'tf_b
ert_model_1/bert/pooler/dense/kernel:0', 'tf_bert_model_1/bert/pooler/dens
e/bias:0'] when minimizing the loss.
WARNING:tensorflow:Gradients do not exist for variables ['tf_bert_model/be
rt/pooler/dense/kernel:0', 'tf_bert_model/bert/pooler/dense/bias:0', 'tf_b
ert_model_1/bert/pooler/dense/kernel:0', 'tf_bert_model_1/bert/pooler/dens
e/bias:0'] when minimizing the loss.
1621/1621 [==============================] - 724s 447ms/step - loss: 0.389
1
Epoch 2/2
1621/1621 [==============================] - 725s 447ms/step - loss: 0.361
9
validation score =  0.3794419062973836
Epoch 1/2
WARNING:tensorflow:Gradients do not exist for variables ['tf_bert_model/be
rt/pooler/dense/kernel:0', 'tf_bert_model/bert/pooler/dense/bias:0', 'tf_b
ert_model_1/bert/pooler/dense/kernel:0', 'tf_bert_model_1/bert/pooler/dens
e/bias:0'] when minimizing the loss.
WARNING:tensorflow:Gradients do not exist for variables ['tf_bert_model/be
rt/pooler/dense/kernel:0', 'tf_bert_model/bert/pooler/dense/bias:0', 'tf_b
ert_model_1/bert/pooler/dense/kernel:0', 'tf_bert_model_1/bert/pooler/dens
e/bias:0'] when minimizing the loss.
WARNING:tensorflow:Gradients do not exist for variables ['tf_bert_model/be
rt/pooler/dense/kernel:0', 'tf_bert_model/bert/pooler/dense/bias:0', 'tf_b
ert_model_1/bert/pooler/dense/kernel:0', 'tf_bert_model_1/bert/pooler/dens
e/bias:0'] when minimizing the loss.
WARNING:tensorflow:Gradients do not exist for variables ['tf_bert_model/be
rt/pooler/dense/kernel:0', 'tf_bert_model/bert/pooler/dense/bias:0', 'tf_b
ert_model_1/bert/pooler/dense/kernel:0', 'tf_bert_model_1/bert/pooler/dens
e/bias:0'] when minimizing the loss.
1621/1621 [==============================] - 726s 448ms/step - loss: 0.389
2
Epoch 2/2
1621/1621 [==============================] - 726s 448ms/step - loss: 0.362
5
validation score =  0.4009730317710084
Epoch 1/2
WARNING:tensorflow:Gradients do not exist for variables ['tf_bert_model/be
rt/pooler/dense/kernel:0', 'tf_bert_model/bert/pooler/dense/bias:0', 'tf_b
ert_model_1/bert/pooler/dense/kernel:0', 'tf_bert_model_1/bert/pooler/dens
e/bias:0'] when minimizing the loss.
WARNING:tensorflow:Gradients do not exist for variables ['tf_bert_model/be
rt/pooler/dense/kernel:0', 'tf_bert_model/bert/pooler/dense/bias:0', 'tf_b
ert_model_1/bert/pooler/dense/kernel:0', 'tf_bert_model_1/bert/pooler/dens
e/bias:0'] when minimizing the loss.
WARNING:tensorflow:Gradients do not exist for variables ['tf_bert_model/be
rt/pooler/dense/kernel:0', 'tf_bert_model/bert/pooler/dense/bias:0', 'tf_b
ert_model_1/bert/pooler/dense/kernel:0', 'tf_bert_model_1/bert/pooler/dens
e/bias:0'] when minimizing the loss.
WARNING:tensorflow:Gradients do not exist for variables ['tf_bert_model/be
rt/pooler/dense/kernel:0', 'tf_bert_model/bert/pooler/dense/bias:0', 'tf_b
ert_model_1/bert/pooler/dense/kernel:0', 'tf_bert_model_1/bert/pooler/dens
e/bias:0'] when minimizing the loss.
1621/1621 [==============================] - 726s 448ms/step - loss: 0.388
9
Epoch 2/2
1621/1621 [==============================] - 726s 448ms/step - loss: 0.362
4
validation score =  0.3928537472619628
Epoch 1/2
WARNING:tensorflow:Gradients do not exist for variables ['tf_bert_model/be
rt/pooler/dense/kernel:0', 'tf_bert_model/bert/pooler/dense/bias:0', 'tf_b
ert_model_1/bert/pooler/dense/kernel:0', 'tf_bert_model_1/bert/pooler/dens
e/bias:0'] when minimizing the loss.
WARNING:tensorflow:Gradients do not exist for variables ['tf_bert_model/be
rt/pooler/dense/kernel:0', 'tf_bert_model/bert/pooler/dense/bias:0', 'tf_b
ert_model_1/bert/pooler/dense/kernel:0', 'tf_bert_model_1/bert/pooler/dens
e/bias:0'] when minimizing the loss.
WARNING:tensorflow:Gradients do not exist for variables ['tf_bert_model/be
rt/pooler/dense/kernel:0', 'tf_bert_model/bert/pooler/dense/bias:0', 'tf_b
ert_model_1/bert/pooler/dense/kernel:0', 'tf_bert_model_1/bert/pooler/dens
e/bias:0'] when minimizing the loss.
WARNING:tensorflow:Gradients do not exist for variables ['tf_bert_model/be
rt/pooler/dense/kernel:0', 'tf_bert_model/bert/pooler/dense/bias:0', 'tf_b
ert_model_1/bert/pooler/dense/kernel:0', 'tf_bert_model_1/bert/pooler/dens
e/bias:0'] when minimizing the loss.
1622/1622 [==============================] - 754s 465ms/step - loss: 0.389
5
Epoch 2/2
1622/1622 [==============================] - 754s 465ms/step - loss: 0.361
7
validation score =  0.3848141605741672
```

Conslusion from Bert Model

- In Bert Model i have taken pretrained Bert model bert-base-uncased. and Maximum lenght of token i have taken 512.
- In Bert i have taken adam Optimser and Binary Cross Entropy as loss.
- In Bert the Best Spearmen Validation i am getting is 0.400973

Roberta Model

In [ ]:

```
import tensorflow as tf
from transformers import RobertaTokenizer, TFRobertaModel
model_name = 'roberta-base'
tokenizer = RobertaTokenizer.from_pretrained(model_name,additional_special_tokens=['<END_TI
MAX_SEQUENCE_LENGTH = 300
```

```
HBox(children=(FloatProgress(value=0.0, description='Downloading', max=89882
3.0, style=ProgressStyle(descripti…


HBox(children=(FloatProgress(value=0.0, description='Downloading', max=45631
8.0, style=ProgressStyle(descripti…
```

In [ ]:

```
## The function to creat the masks using to the title, question and answer
def convert_to_Bert_inputs(title, question, answer, tokenizer, max_sequence_length):
    """Converts tokenized input to ids, masks and segments for transformer (including bert)

    def return_bert_ids(str1, str2, truncation_strategy, length):

        inputs = tokenizer.encode_plus(str1, str2,add_special_tokens=True,max_length=length

        input_ids =  inputs["input_ids"]
        # input_segments = inputs["token_type_ids"]
        input_masks = inputs["attention_mask"]
        # return [input_ids, input_masks, input_segments]
        return [input_ids, input_masks]


    # input_ids_question, input_masks_question, input_segments_question = return_bert_ids(
    #     title + ' ' + question, None, 'longest_first', max_sequence_length)

    # input_ids_answer, input_masks_answer, input_segments_answer = return_bert_ids(
    #     answer, None, 'longest_first', max_sequence_length)
    input_ids_question, input_masks_question = return_bert_ids(
        title + ' ' + question, None, 'longest_first', max_sequence_length)

    input_ids_answer, input_masks_answer = return_bert_ids(
        answer, None, 'longest_first', max_sequence_length)

    # return [input_ids_question, input_masks_question, input_segments_question,
    #         input_ids_answer, input_masks_answer, input_segments_answer]
    return [input_ids_question, input_masks_question,
            input_ids_answer, input_masks_answer]
```

In [ ]:

```
# Computing the inputs
def compute_input_Bert(df, columns, tokenizer, max_sequence_length):

    # input_ids_question, input_masks_question, input_segments_question = [], [], []
    # input_ids_answer, input_masks_answer, input_segments_answer = [], [], []
    input_ids_question, input_masks_question = [], []
    input_ids_answer, input_masks_answer = [], []

    for indexes, series_data in tqdm(df[columns].iterrows()):

        t, q, a = series_data.question_title, series_data.question_body, series_data.answer

        ids_q, masks_q, ids_a, masks_a = convert_to_Bert_inputs(t, q, a, tokenizer, max_sec

        input_ids_question.append(ids_q)
        input_masks_question.append(masks_q)
        # input_segments_question.append(segments_q)

        input_ids_answer.append(ids_a)
        input_masks_answer.append(masks_a)
        # input_segments_answer.append(segments_a)

    return [np.asarray(input_ids_question, dtype=np.int32),
            np.asarray(input_masks_question, dtype=np.int32),
            np.asarray(input_ids_answer, dtype=np.int32),
            np.asarray(input_masks_answer, dtype=np.int32)]
```

In [ ]:

```
def create_model(model_name):

    config = RobertaConfig()
    config.output_hidden_states = False

    question_bert_model = TFRobertaModel.from_pretrained(model_name)
    answer_bert_model = TFRobertaModel.from_pretrained(model_name)


    question_enc = tf.keras.layers.Input((MAX_SEQUENCE_LENGTH,), dtype=tf.int32)
    question_mask = tf.keras.layers.Input((MAX_SEQUENCE_LENGTH,), dtype=tf.int32)
    question_type_ids = tf.keras.layers.Input((MAX_SEQUENCE_LENGTH,), dtype=tf.int32)

    answer_enc = tf.keras.layers.Input((MAX_SEQUENCE_LENGTH,), dtype=tf.int32)
    answer_mask = tf.keras.layers.Input((MAX_SEQUENCE_LENGTH,), dtype=tf.int32)
    answer_type_ids = tf.keras.layers.Input((MAX_SEQUENCE_LENGTH,), dtype=tf.int32)

    question_bert = question_bert_model(question_enc, attention_mask=question_mask)[0]
    answer_bert = answer_bert_model(answer_enc, attention_mask=answer_mask)[0]

    question_bert_summary = tf.keras.layers.Flatten()(tf.keras.layers.AveragePooling1D(MAX_
    answer_bert_summary = tf.keras.layers.Flatten()(tf.keras.layers.AveragePooling1D(MAX_SE

    combined_bert_summary = tf.keras.layers.Concatenate()([question_bert_summary, answer_be
    dropout_bert = tf.keras.layers.Dropout(0.2)(combined_bert_summary)
    output = tf.keras.layers.Dense(30, activation='sigmoid')(dropout_bert)
    model = tf.keras.models.Model(inputs=[question_enc, question_mask, answer_enc, answer_m
    print(model.summary())
    return model
```

In [ ]:

```
def compute_output_arrays(df, columns):
    return np.asarray(df[columns])
```

In [ ]:

```
final_dataset_target.shape
```

Out[25]:

```
(6079, 30)
```

In [ ]:

```
inputs = compute_input_Bert(final_dataset, final_dataset.columns, tokenizer, MAX_SEQUENCE_L
outputs = compute_output_arrays(final_dataset_target, final_dataset_target.columns)
```

```
6079it [00:18, 326.07it/s]
```

In [ ]:

```
cvFold = GroupKFold(n_splits=5).split(X=final_dataset.question_body, groups=final_dataset.q

## to receive predictions
valid_preds = []

## Looping throught the folds
for fold, (train_idx, valid_idx) in enumerate(cvFold):


        ## Train index from Kfold
        train_inputs = [inputs[i][train_idx] for i in range(len(inputs))]
        train_outputs = outputs[train_idx]
        ## Valid index from Kfold
        valid_inputs = [inputs[i][valid_idx] for i in range(len(inputs))]
        valid_outputs = outputs[valid_idx]

        K.clear_session()

        ## Instantiating the Bert Model
        model = create_model(model_name)
        optimizer = tf.keras.optimizers.Adam(learning_rate=2e-5)
        model.compile(loss='binary_crossentropy', optimizer=optimizer)
        ## Fiting the model
        model.fit(train_inputs, train_outputs, epochs=2, batch_size=3)

        valid_preds.append(model.predict(valid_inputs))

        # Calculating the error in the valid set
        rho_val = compute_spearmanr_ignore_nan(valid_outputs, valid_preds[-1])
        print('validation score = ', rho_val)
```

```
HBox(children=(FloatProgress(value=0.0, description='Downloading', max=48
1.0, style=ProgressStyle(description_…



HBox(children=(FloatProgress(value=0.0, description='Downloading', max=657
434796.0, style=ProgressStyle(descri…
```

Conclusion from Roberta Model

- In Roberta Model i have taken pretrained Roberta model roberta-base. and Maximum lenght of token i have taken 512.
- In Roberta i have taken adam Optimser and Binary Cross Entropy as loss.

- In Roberta the Best Spearmen Validation i am getting is 0.3953

XLNET Model

In [ ]:

```
import tensorflow as tf
from transformers import XLNetTokenizer, TFXLNetModel
model_name =   'xlnet-base-cased'
tokenizer = XLNetTokenizer.from_pretrained('xlnet-base-cased',additional_special_tokens=['<
MAX_SEQUENCE_LENGTH = 512
```

```
HBox(children=(FloatProgress(value=0.0, description='Downloading', max=79801
1.0, style=ProgressStyle(descripti…
```

In [ ]:

```
## The function to creat the masks using to the title, question and answer
def convert_to_Bert_inputs(title, question, answer, tokenizer, max_sequence_length):
    """Converts tokenized input to ids, masks and segments for transformer (including bert)

    def return_bert_ids(str1, str2, truncation_strategy, length):

        inputs = tokenizer.encode_plus(str1, str2,add_special_tokens=True,max_length=length

        input_ids =  inputs["input_ids"]
        input_segments = inputs["token_type_ids"]
        input_masks = inputs["attention_mask"]
        return [input_ids, input_masks, input_segments]

    input_ids_question, input_masks_question, input_segments_question = return_bert_ids(
        title + ' ' + question, None, 'longest_first', max_sequence_length)

    input_ids_answer, input_masks_answer, input_segments_answer = return_bert_ids(
        answer, None, 'longest_first', max_sequence_length)

    return [input_ids_question, input_masks_question, input_segments_question,
            input_ids_answer, input_masks_answer, input_segments_answer]
```

In [ ]:

```
# Computing the inputs
def compute_input_Bert(df, columns, tokenizer, max_sequence_length):

    input_ids_question, input_masks_question, input_segments_question = [], [], []
    input_ids_answer, input_masks_answer, input_segments_answer = [], [], []

    for indexes, series_data in tqdm(df[columns].iterrows()):

        t, q, a = series_data.question_title, series_data.question_body, series_data.answer

        ids_q, masks_q, segments_q, ids_a, masks_a, segments_a = convert_to_Bert_inputs(t,

        input_ids_question.append(ids_q)
        input_masks_question.append(masks_q)
        input_segments_question.append(segments_q)

        input_ids_answer.append(ids_a)
        input_masks_answer.append(masks_a)
        input_segments_answer.append(segments_a)

    return [np.asarray(input_ids_question, dtype=np.int32),
            np.asarray(input_masks_question, dtype=np.int32),
            np.asarray(input_segments_question, dtype=np.int32),
            np.asarray(input_ids_answer, dtype=np.int32),
            np.asarray(input_masks_answer, dtype=np.int32),
            np.asarray(input_segments_answer, dtype=np.int32)]
```

In [ ]:

```
## Computing the error metric to the model optimization
def compute_spearmanr_ignore_nan(trues, preds):
    rhos = []
    for tcol, pcol in zip(np.transpose(trues), np.transpose(preds)):
        rhos.append(spearmanr(tcol, pcol).correlation)
    return np.nanmean(rhos)
```

In [ ]:

```
def create_model(model_name):

    config = XLNetConfig()
    config.output_hidden_states = False

    question_bert_model = TFXLNetModel.from_pretrained(model_name)
    answer_bert_model = TFXLNetModel.from_pretrained(model_name)


    question_enc = tf.keras.layers.Input((MAX_SEQUENCE_LENGTH,), dtype=tf.int32)
    question_mask = tf.keras.layers.Input((MAX_SEQUENCE_LENGTH,), dtype=tf.int32)
    question_type_ids = tf.keras.layers.Input((MAX_SEQUENCE_LENGTH,), dtype=tf.int32)

    answer_enc = tf.keras.layers.Input((MAX_SEQUENCE_LENGTH,), dtype=tf.int32)
    answer_mask = tf.keras.layers.Input((MAX_SEQUENCE_LENGTH,), dtype=tf.int32)
    answer_type_ids = tf.keras.layers.Input((MAX_SEQUENCE_LENGTH,), dtype=tf.int32)

    question_bert = question_bert_model(question_enc, attention_mask=question_mask, token_t
    answer_bert = answer_bert_model(answer_enc, attention_mask=answer_mask, token_type_ids=

    question_bert_summary = tf.keras.layers.Flatten()(tf.keras.layers.AveragePooling1D(MAX_
    answer_bert_summary = tf.keras.layers.Flatten()(tf.keras.layers.AveragePooling1D(MAX_SE

    combined_bert_summary = tf.keras.layers.Concatenate()([question_bert_summary, answer_be
    dropout_bert = tf.keras.layers.Dropout(0.2)(combined_bert_summary)
    output = tf.keras.layers.Dense(30, activation='sigmoid')(dropout_bert)
    model = tf.keras.models.Model(inputs=[question_enc, question_mask, question_type_ids, a

    return model
```

In [ ]:

```
def compute_output_arrays(df, columns):
    return np.asarray(df[columns])
```

In [ ]:

```
final_dataset_target.shape
```

Out[34]:

```
(6079, 30)
```

In [ ]:

```
inputs = compute_input_Bert(final_dataset, final_dataset.columns, tokenizer, MAX_SEQUENCE_L
outputs = compute_output_arrays(final_dataset_target, final_dataset_target.columns)
```

```
6079it [00:12, 477.04it/s]
```

In [ ]:

```
cvFold = GroupKFold(n_splits=5).split(X=final_dataset.question_body, groups=final_dataset.q

## to receive predictions
valid_preds = []

## Looping throught the folds
for fold, (train_idx, valid_idx) in enumerate(cvFold):


        ## Train index from Kfold
        train_inputs = [inputs[i][train_idx] for i in range(len(inputs))]
        train_outputs = outputs[train_idx]
        ## Valid index from Kfold
        valid_inputs = [inputs[i][valid_idx] for i in range(len(inputs))]
        valid_outputs = outputs[valid_idx]

        K.clear_session()

        ## Instantiating the Bert Model
        model = create_model(model_name)
        optimizer = tf.keras.optimizers.Adam(learning_rate=2e-5)
        model.compile(loss='binary_crossentropy', optimizer=optimizer)
        ## Fiting the model
        model.fit(train_inputs, train_outputs, epochs=2, batch_size=3)

        valid_preds.append(model.predict(valid_inputs))

        # Calculating the error in the valid set
        rho_val = compute_spearmanr_ignore_nan(valid_outputs, valid_preds[-1])
        print('validation score = ', rho_val)
```

```
HBox(children=(FloatProgress(value=0.0, description='Downloading', max=760.
0, style=ProgressStyle(description_…



HBox(children=(FloatProgress(value=0.0, description='Downloading', max=56548
5600.0, style=ProgressStyle(descri…


Epoch 1/2
WARNING:tensorflow:Gradients do not exist for variables ['tfxl_net_model/tra
nsformer/mask_emb:0', 'tfxl_net_model_1/transformer/mask_emb:0'] when minimi
zing the loss.
WARNING:tensorflow:Gradients do not exist for variables ['tfxl_net_model/tra
nsformer/mask_emb:0', 'tfxl_net_model_1/transformer/mask_emb:0'] when minimi
zing the loss.
WARNING:tensorflow:Gradients do not exist for variables ['tfxl_net_model/tra
nsformer/mask_emb:0', 'tfxl_net_model_1/transformer/mask_emb:0'] when minimi
zing the loss.
WARNING:tensorflow:Gradients do not exist for variables ['tfxl_net_model/tra
nsformer/mask_emb:0', 'tfxl_net_model_1/transformer/mask_emb:0'] when minimi
zing the loss.
1621/1621 [==============================] - 1507s 930ms/step - loss: 0.4002
Epoch 2/2
1621/1621 [==============================] - 1507s 930ms/step - loss: 0.3690
validation score =  0.38563955478464107
Epoch 1/2
WARNING:tensorflow:Gradients do not exist for variables ['tfxl_net_model/tra
nsformer/mask_emb:0', 'tfxl_net_model_1/transformer/mask_emb:0'] when minimi
zing the loss.
WARNING:tensorflow:Gradients do not exist for variables ['tfxl_net_model/tra
nsformer/mask_emb:0', 'tfxl_net_model_1/transformer/mask_emb:0'] when minimi
zing the loss.
WARNING:tensorflow:Gradients do not exist for variables ['tfxl_net_model/tra
nsformer/mask_emb:0', 'tfxl_net_model_1/transformer/mask_emb:0'] when minimi
zing the loss.
WARNING:tensorflow:Gradients do not exist for variables ['tfxl_net_model/tra
nsformer/mask_emb:0', 'tfxl_net_model_1/transformer/mask_emb:0'] when minimi
zing the loss.
1621/1621 [==============================] - 1507s 930ms/step - loss: 0.3993
Epoch 2/2
1621/1621 [==============================] - 1507s 930ms/step - loss: 0.3681
validation score =  0.3832372904332695
Epoch 1/2
WARNING:tensorflow:Gradients do not exist for variables ['tfxl_net_model/tra
nsformer/mask_emb:0', 'tfxl_net_model_1/transformer/mask_emb:0'] when minimi
zing the loss.
WARNING:tensorflow:Gradients do not exist for variables ['tfxl_net_model/tra
nsformer/mask_emb:0', 'tfxl_net_model_1/transformer/mask_emb:0'] when minimi
zing the loss.
WARNING:tensorflow:Gradients do not exist for variables ['tfxl_net_model/tra
nsformer/mask_emb:0', 'tfxl_net_model_1/transformer/mask_emb:0'] when minimi
zing the loss.
WARNING:tensorflow:Gradients do not exist for variables ['tfxl_net_model/tra
nsformer/mask_emb:0', 'tfxl_net_model_1/transformer/mask_emb:0'] when minimi
zing the loss.
1621/1621 [==============================] - 1510s 932ms/step - loss: 0.4000
Epoch 2/2
1621/1621 [==============================] - 1510s 931ms/step - loss: 0.3691
validation score =  0.40099871275773696
Epoch 1/2
WARNING:tensorflow:Gradients do not exist for variables ['tfxl_net_model/tra
nsformer/mask_emb:0', 'tfxl_net_model_1/transformer/mask_emb:0'] when minimi
zing the loss.
WARNING:tensorflow:Gradients do not exist for variables ['tfxl_net_model/tra
nsformer/mask_emb:0', 'tfxl_net_model_1/transformer/mask_emb:0'] when minimi
zing the loss.
WARNING:tensorflow:Gradients do not exist for variables ['tfxl_net_model/tra
nsformer/mask_emb:0', 'tfxl_net_model_1/transformer/mask_emb:0'] when minimi
zing the loss.
WARNING:tensorflow:Gradients do not exist for variables ['tfxl_net_model/tra
nsformer/mask_emb:0', 'tfxl_net_model_1/transformer/mask_emb:0'] when minimi
zing the loss.
1621/1621 [==============================] - 1509s 931ms/step - loss: 0.4017
Epoch 2/2
1621/1621 [==============================] - 1509s 931ms/step - loss: 0.3709
validation score =  0.3883445588779967
Epoch 1/2
WARNING:tensorflow:Gradients do not exist for variables ['tfxl_net_model/tra
nsformer/mask_emb:0', 'tfxl_net_model_1/transformer/mask_emb:0'] when minimi
zing the loss.
WARNING:tensorflow:Gradients do not exist for variables ['tfxl_net_model/tra
nsformer/mask_emb:0', 'tfxl_net_model_1/transformer/mask_emb:0'] when minimi
zing the loss.
WARNING:tensorflow:Gradients do not exist for variables ['tfxl_net_model/tra
nsformer/mask_emb:0', 'tfxl_net_model_1/transformer/mask_emb:0'] when minimi
zing the loss.
WARNING:tensorflow:Gradients do not exist for variables ['tfxl_net_model/tra
nsformer/mask_emb:0', 'tfxl_net_model_1/transformer/mask_emb:0'] when minimi
```

```
zing the loss.
1622/1622 [==============================] - 1537s 947ms/step - loss: 0.3971
Epoch 2/2
1622/1622 [==============================] - 1537s 948ms/step - loss: 0.3679
validation score =  0.3902941355388541
```

Conclusion from XLNET Model

- In XLNET Model i have taken pretrained XLNET model xlnet-base-cased. and Maximum lenght of token i have taken 512.
- In XLNET i have taken adam Optimser and Binary Cross Entropy as loss.
- In XLNET the Best Spearmen Validation i am getting is 0.40098

Observation from Model 1

We have taken 3 Preprocessed text i.e preprocessed_question_title, preprocessed_question_body ,preprocessed_answer_body and 2 catrgorical Input i.e host and category.

In Model 1 For text data i have used universal Sentance Encoder to Build a Embeeding Matrix of size 512(max size).

In Model 1 Activation unit "Relu" is used and kernel_initializer as "he normal" , Optimiser as a "Binary Cross Entropy" . loss as mean_absolute_error as it is more robust to the Outlier and to avoid vanishing gradient.

Train loss - 0.3883 validation Loss - 0.40

There difference between training loss and validation loss is very . it means model is very less Overfitting.

Spearsmen validation score = 0.3490

Observation from Model 2 Recurring Neural Network LSTM

We have taken 3 Preprocessed text i.e preprocessed_question_title, preprocessed_question_body ,preprocessed_answer_body and 2 catrgorical Input i.e host and category.

In Model 2 For text data i have used Fastext Word vector to Build a Embeeding Matrix of size 300(max size).

for text data i have used word tokenizer to build to text data set and maximum length of tokenizer i have used is 600 and pre padding is applied.

In Model 2 Activation unit "Relu" is used and kernel_initializer as "he normal" , Optimiser as a "Binary CrossEntropy" . loss as mean_absolute_error as it is more robust to the Outlier and to avoid vanishing gradient.

Train loss - 0.51 validation Loss - 0.54

There is More difference between training loss and Validation loss as compared to model 1. Model 2 is more overfitiing than model1.

Spearsmen validation score = 0.300251

Observation from Model 3 Recurring Neural Network CN

Here in CNN we have used conv1d and maxPooling of 1 d.

We have taken 3 Preprocessed text i.e preprocessed_question_title, preprocessed_question_body ,preprocessed_answer_body and 2 catrgorical Input i.e host and category.

In Model 3 For text data i have used Fastext Word vector to Build a Embeeding Matrix of size 300(max size).

for text data i have used word tokenizer to build to text data set and maximum length of tokenizer i have used is 600 and pre padding is applied.

In Model 3 Activation unit "Relu" is used and kernel_initializer as "he normal" , Optimiser as a "Binary Cross Entropy" . loss as mean_absolute_error as it is more robust to the Outlier and to avoid vanishing gradient.

Train loss - 0.50 validation Loss - 0.53

There is difference between training loss and validation loss os 0.3. model with CNN is performingsimilar to LSTM

Spearsmen validation score = 0.31

Observation from Model 4 Recurring Neural Network CNN and LSTM

Here in CNN and LSTM we have used conv1d and maxPooling of 1d and 1LSTM Layer

We have taken 3 Preprocessed text i.e preprocessed_question_title, preprocessed_question_body ,preprocessed_answer_body and 2 catrgorical Input i.e host and category.

In Model 4 For text data i have used Fastext Word vector to Build a Embeeding Matrix of size 300(max size).

for text data i have used word tokenizer to build to text data set and maximum length of tokenizer i have used is 600 and pre padding is applied.

In Model 4 Activation unit "Relu" is used and kernel_initializer as "he normal" , Optimiser as a "adam" . loss as Binary Cross Entropy as it is more robust to the Outlier and to avoid vanishing gradient.

Train loss - 0.46 validation Loss - 0.51

There is 0.5 difference between training loss and validation loss. model with CNN and LSTM is performing worse than Model1 and Model 3

Spearsmen validation score = 0.29

Observation From Model 5 Transformer Bert Model

In Model 5 i have used the Pretrained Transformer Bert model.

I have used the pretrained tokenizer and pretrained Bert Model i.e bert-base-uncased and taken 512 lenght of token.

I have Question body , question title and answer as text data and token it and encode using encode.plus which return me input_ids token_type_ids and attention_mask.

The Best loss i am getting is 0.3617 in Bert Model.

In Bert the Best Spearmen Validation i am getting is 0.40097.

Observation From Model 6 Transformer Roberta Model

In Model 6 i have used the Pretrained Transformer Roberta model.

I have used the pretrained tokenizer and pretrained Roberta Model i.e roberta-base and taken 300 lenght of token.

I have Question body , question title and answer as text data and token it and encode using encode.plus which return me input_ids token_type_ids and attention_mask.

The Best loss i am getting is 0.3817 in Bert Model.

In Bert the Best Spearmen Validation i am getting is 0.3953.

Observation From Model 7 Transformer XLNET Model

In Model 7 i have used the Pretrained Transformer XLnet model.

I have used the pretrained tokenizer and pretrained XLNET Model i.e xlnet-base-cased and taken 512 lenght of token.

I have Question body , question title and answer as text data and token it and encode using encode.plus which return me input_ids token_type_ids and attention_mask.

The Best loss i am getting is 0.3617 in Bert Model.

In Bert the Best Spearmen Validation i am getting is 0.400098.

In [ ]:

```
# http://zetcode.com/python/prettytable/
from prettytable import PrettyTable
x = PrettyTable()
x.field_names = ["Sentence Vectoriser","Model" ,"Train Loss" , "validation Loss","SpearmenV
x.add_row(["Universal Sentence Encoder", "Model_1",0.38,0.40,0.349 ])
x.add_row(["Fastext Word Vector", "Model_2",0.51,0.54,0.30 ])
x.add_row(["Fastext Word Vector", "Model_3",0.50,0.53,0.31 ])
x.add_row(["Fastext Word Vector", "Model_4",0.46,0.51,0.29 ])



print(x)
```

```
+----------------------------+---------+------------+-----------------+-----
---------------------+
|    Sentence Vectoriser     |  Model  | Train Loss | validation Loss | Spea
rmenValidation Score |
+----------------------------+---------+------------+-----------------+-----
---------------------+
| Universal Sentence Encoder | Model_1 |    0.38    |       0.4       |
0.349                |
|    Fastext Word Vector     | Model_2 |    0.51    |       0.54      |
0.3                  |
|    Fastext Word Vector     | Model_3 |    0.5     |       0.53      |
0.31                 |
|    Fastext Word Vector     | Model_4 |    0.46    |       0.51      |
0.29                 |
+----------------------------+---------+------------+-----------------+-----
---------------------+
```

In [ ]:

```
# http://zetcode.com/python/prettytable/
from prettytable import PrettyTable
x = PrettyTable()
x.field_names = ["Model" ,"Train Loss" ,"SpearmenValidation Score" ]
x.add_row(["Bert Base" , "0.3617" , 0.40097])
x.add_row(["Roberta" , "0.3817" , 0.3953])
x.add_row(["XLNEt" , "0.3614" , 0.40099])

print(x)
```

```
+-----------+------------+--------------------------+
|   Model   | Train Loss | SpearmenValidation Score |
+-----------+------------+--------------------------+
| Bert Base |   0.3617   |         0.40097          |
|  Roberta  |   0.3817   |          0.3953          |
|   XLNEt   |   0.3614   |         0.40099          |
+-----------+------------+--------------------------+
```

Error analysis of the best model.

In [78]:

```
print('Reading data...')
train_data = pd.read_csv('/content/drive/My Drive/Google/train.csv')
test_data = pd.read_csv('/content/drive/My Drive/Google/test.csv')
sample_submission = pd.read_csv('/content/drive/My Drive/Google/sample_submission.csv')
print('Reading data completed')
```

```
Reading data...
Reading data completed
```

In [79]:

```
target_columns = list(sample_submission.columns)[1:]
print(len(target_columns))
print(target_columns)
final_dataset = train_data.drop(target_columns, axis=1)
final_dataset_target = train_data[target_columns].copy()
```

```
30
['question_asker_intent_understanding', 'question_body_critical', 'question_
conversational', 'question_expect_short_answer', 'question_fact_seeking', 'q
uestion_has_commonly_accepted_answer', 'question_interestingness_others', 'q
uestion_interestingness_self', 'question_multi_intent', 'question_not_really
_a_question', 'question_opinion_seeking', 'question_type_choice', 'question_
type_compare', 'question_type_consequence', 'question_type_definition', 'que
stion_type_entity', 'question_type_instructions', 'question_type_procedure',
'question_type_reason_explanation', 'question_type_spelling', 'question_well
_written', 'answer_helpful', 'answer_level_of_information', 'answer_plausibl
e', 'answer_relevance', 'answer_satisfaction', 'answer_type_instructions',
'answer_type_procedure', 'answer_type_reason_explanation', 'answer_well_writ
ten']
```

In [80]:

```
print(final_dataset.shape)
print(final_dataset_target.shape)
```

```
(6079, 11)
(6079, 30)
```

In [81]:

```
print(final_dataset.shape)
print("=="*62)
from sklearn.model_selection import train_test_split
project_data_train, project_data_cv, result_data_train, result_data_cv = train_test_split(f
print(project_data_train.shape,project_data_cv.shape)
print(result_data_train.shape,result_data_cv.shape)
```

```
(6079, 11)
============================================================================
================================================
(4863, 11) (1216, 11)
(4863, 30) (1216, 30)
```

In [82]:

```
model_name = 'bert-base-uncased'
tokenizer = BertTokenizer.from_pretrained('bert-base-uncased',additional_special_tokens=['<
MAX_SEQUENCE_LENGTH = 512
```

In [83]:

```
## The function to creat the masks using to the title, question and answer
def convert_to_Bert_inputs(title, question, answer, tokenizer, max_sequence_length):
    """Converts tokenized input to ids, masks and segments for transformer (including bert)

    def return_bert_ids(str1, str2, truncation_strategy, length):

        inputs = tokenizer.encode_plus(str1, str2,add_special_tokens=True,max_length=length

        input_ids =  inputs["input_ids"]
        input_segments = inputs["token_type_ids"]
        input_masks = inputs["attention_mask"]
        return [input_ids, input_masks, input_segments]

    input_ids_question, input_masks_question, input_segments_question = return_bert_ids(
        title + ' ' + question, None, 'longest_first', max_sequence_length)

    input_ids_answer, input_masks_answer, input_segments_answer = return_bert_ids(
        answer, None, 'longest_first', max_sequence_length)

    return [input_ids_question, input_masks_question, input_segments_question,
            input_ids_answer, input_masks_answer, input_segments_answer]
```

In [84]:

```
# Computing the inputs
def compute_input_Bert(df, columns, tokenizer, max_sequence_length):

    input_ids_question, input_masks_question, input_segments_question = [], [], []
    input_ids_answer, input_masks_answer, input_segments_answer = [], [], []

    for indexes, series_data in tqdm(df[columns].iterrows()):

        t, q, a = series_data.question_title, series_data.question_body, series_data.answer

        ids_q, masks_q, segments_q, ids_a, masks_a, segments_a = convert_to_Bert_inputs(t,

        input_ids_question.append(ids_q)
        input_masks_question.append(masks_q)
        input_segments_question.append(segments_q)

        input_ids_answer.append(ids_a)
        input_masks_answer.append(masks_a)
        input_segments_answer.append(segments_a)

    return [np.asarray(input_ids_question, dtype=np.int32),
            np.asarray(input_masks_question, dtype=np.int32),
            np.asarray(input_segments_question, dtype=np.int32),
            np.asarray(input_ids_answer, dtype=np.int32),
            np.asarray(input_masks_answer, dtype=np.int32),
            np.asarray(input_segments_answer, dtype=np.int32)]
```

In [85]:

```
## Computing the error metric to the model optimization
def compute_spearmanr_ignore_nan(trues, preds):
    rhos = []
    for tcol, pcol in zip(np.transpose(trues), np.transpose(preds)):
        rhos.append(spearmanr(tcol, pcol).correlation)
    return np.nanmean(rhos)
```

In [86]:

```
def create_model(model_name):

    config = BertConfig()
    config.output_hidden_states = False

    question_bert_model = TFBertModel.from_pretrained(model_name, config=config)
    answer_bert_model = TFBertModel.from_pretrained(model_name, config=config)


    question_enc = tf.keras.layers.Input((MAX_SEQUENCE_LENGTH,), dtype=tf.int32)
    question_mask = tf.keras.layers.Input((MAX_SEQUENCE_LENGTH,), dtype=tf.int32)
    question_type_ids = tf.keras.layers.Input((MAX_SEQUENCE_LENGTH,), dtype=tf.int32)

    answer_enc = tf.keras.layers.Input((MAX_SEQUENCE_LENGTH,), dtype=tf.int32)
    answer_mask = tf.keras.layers.Input((MAX_SEQUENCE_LENGTH,), dtype=tf.int32)
    answer_type_ids = tf.keras.layers.Input((MAX_SEQUENCE_LENGTH,), dtype=tf.int32)

    question_bert = question_bert_model(question_enc, attention_mask=question_mask, token_t
    answer_bert = answer_bert_model(answer_enc, attention_mask=answer_mask, token_type_ids=

    question_bert_summary = tf.keras.layers.Flatten()(tf.keras.layers.AveragePooling1D(MAX_
    answer_bert_summary = tf.keras.layers.Flatten()(tf.keras.layers.AveragePooling1D(MAX_SE

    combined_bert_summary = tf.keras.layers.Concatenate()([question_bert_summary, answer_be
    dropout_bert = tf.keras.layers.Dropout(0.2)(combined_bert_summary)
    output = tf.keras.layers.Dense(30, activation='sigmoid')(dropout_bert)
    model = tf.keras.models.Model(inputs=[question_enc, question_mask, question_type_ids, a

    return model
```

In [87]:

```
def compute_output_arrays(df, columns):
    return np.asarray(df[columns])
```

In [88]:

```
inputs = compute_input_Bert(final_dataset, final_dataset.columns, tokenizer, MAX_SEQUENCE_L
outputs = compute_output_arrays(final_dataset_target, final_dataset_target.columns)
```

```
6079it [00:47, 129.06it/s]
```

In [89]:

```
cvFold = GroupKFold(n_splits=5).split(X=final_dataset.question_body, groups=final_dataset.q

## to receive predictions
valid_preds = []

## Looping throught the folds
for fold, (train_idx, valid_idx) in enumerate(cvFold):


        ## Train index from Kfold
        train_inputs = [inputs[i][train_idx] for i in range(len(inputs))]
        train_outputs = outputs[train_idx]
        ## Valid index from Kfold
        valid_inputs = [inputs[i][valid_idx] for i in range(len(inputs))]
        valid_outputs = outputs[valid_idx]

        K.clear_session()

        ## Instantiating the Bert Model
        model = create_model(model_name)
        optimizer = tf.keras.optimizers.Adam(learning_rate=2e-5)
        model.compile(loss='binary_crossentropy', optimizer=optimizer)
        ## Fiting the model
        model.fit(train_inputs, train_outputs, epochs=2, batch_size=3)

        valid_preds.append(model.predict(valid_inputs))

        # Calculating the error in the valid set
        rho_val = compute_spearmanr_ignore_nan(valid_outputs, valid_preds[-1])
        print('validation score = ', rho_val)
```

```
Epoch 1/2
WARNING:tensorflow:Gradients do not exist for variables ['tf_bert_model/ber
t/pooler/dense/kernel:0', 'tf_bert_model/bert/pooler/dense/bias:0', 'tf_bert
_model_1/bert/pooler/dense/kernel:0', 'tf_bert_model_1/bert/pooler/dense/bia
s:0'] when minimizing the loss.
WARNING:tensorflow:Gradients do not exist for variables ['tf_bert_model/ber
t/pooler/dense/kernel:0', 'tf_bert_model/bert/pooler/dense/bias:0', 'tf_bert
_model_1/bert/pooler/dense/kernel:0', 'tf_bert_model_1/bert/pooler/dense/bia
s:0'] when minimizing the loss.
WARNING:tensorflow:Gradients do not exist for variables ['tf_bert_model/ber
t/pooler/dense/kernel:0', 'tf_bert_model/bert/pooler/dense/bias:0', 'tf_bert
_model_1/bert/pooler/dense/kernel:0', 'tf_bert_model_1/bert/pooler/dense/bia
s:0'] when minimizing the loss.
WARNING:tensorflow:Gradients do not exist for variables ['tf_bert_model/ber
t/pooler/dense/kernel:0', 'tf_bert_model/bert/pooler/dense/bias:0', 'tf_bert
_model_1/bert/pooler/dense/kernel:0', 'tf_bert_model_1/bert/pooler/dense/bia
s:0'] when minimizing the loss.
1621/1621 [==============================] - 730s 450ms/step - loss: 0.3881
Epoch 2/2
1621/1621 [==============================] - 730s 450ms/step - loss: 0.3604
validation score =  0.38649105832265535
Epoch 1/2
WARNING:tensorflow:Gradients do not exist for variables ['tf_bert_model/ber
t/pooler/dense/kernel:0', 'tf_bert_model/bert/pooler/dense/bias:0', 'tf_bert
_model_1/bert/pooler/dense/kernel:0', 'tf_bert_model_1/bert/pooler/dense/bia
s:0'] when minimizing the loss.
WARNING:tensorflow:Gradients do not exist for variables ['tf_bert_model/ber
```

```
t/pooler/dense/kernel:0', 'tf_bert_model/bert/pooler/dense/bias:0', 'tf_bert
_model_1/bert/pooler/dense/kernel:0', 'tf_bert_model_1/bert/pooler/dense/bia
s:0'] when minimizing the loss.
WARNING:tensorflow:Gradients do not exist for variables ['tf_bert_model/ber
t/pooler/dense/kernel:0', 'tf_bert_model/bert/pooler/dense/bias:0', 'tf_bert
_model_1/bert/pooler/dense/kernel:0', 'tf_bert_model_1/bert/pooler/dense/bia
s:0'] when minimizing the loss.
WARNING:tensorflow:Gradients do not exist for variables ['tf_bert_model/ber
t/pooler/dense/kernel:0', 'tf_bert_model/bert/pooler/dense/bias:0', 'tf_bert
_model_1/bert/pooler/dense/kernel:0', 'tf_bert_model_1/bert/pooler/dense/bia
s:0'] when minimizing the loss.
1621/1621 [==============================] - 728s 449ms/step - loss: 0.3888
Epoch 2/2
1621/1621 [==============================] - 728s 449ms/step - loss: 0.3611
validation score =  0.3839609378369838
Epoch 1/2
WARNING:tensorflow:Gradients do not exist for variables ['tf_bert_model/ber
t/pooler/dense/kernel:0', 'tf_bert_model/bert/pooler/dense/bias:0', 'tf_bert
_model_1/bert/pooler/dense/kernel:0', 'tf_bert_model_1/bert/pooler/dense/bia
s:0'] when minimizing the loss.
WARNING:tensorflow:Gradients do not exist for variables ['tf_bert_model/ber
t/pooler/dense/kernel:0', 'tf_bert_model/bert/pooler/dense/bias:0', 'tf_bert
_model_1/bert/pooler/dense/kernel:0', 'tf_bert_model_1/bert/pooler/dense/bia
s:0'] when minimizing the loss.
WARNING:tensorflow:Gradients do not exist for variables ['tf_bert_model/ber
t/pooler/dense/kernel:0', 'tf_bert_model/bert/pooler/dense/bias:0', 'tf_bert
_model_1/bert/pooler/dense/kernel:0', 'tf_bert_model_1/bert/pooler/dense/bia
s:0'] when minimizing the loss.
WARNING:tensorflow:Gradients do not exist for variables ['tf_bert_model/ber
t/pooler/dense/kernel:0', 'tf_bert_model/bert/pooler/dense/bias:0', 'tf_bert
_model_1/bert/pooler/dense/kernel:0', 'tf_bert_model_1/bert/pooler/dense/bia
s:0'] when minimizing the loss.
1621/1621 [==============================] - 729s 450ms/step - loss: 0.3926
Epoch 2/2
1621/1621 [==============================] - 729s 450ms/step - loss: 0.3630
validation score =  0.4002797989665155
Epoch 1/2
WARNING:tensorflow:Gradients do not exist for variables ['tf_bert_model/ber
t/pooler/dense/kernel:0', 'tf_bert_model/bert/pooler/dense/bias:0', 'tf_bert
_model_1/bert/pooler/dense/kernel:0', 'tf_bert_model_1/bert/pooler/dense/bia
s:0'] when minimizing the loss.
WARNING:tensorflow:Gradients do not exist for variables ['tf_bert_model/ber
t/pooler/dense/kernel:0', 'tf_bert_model/bert/pooler/dense/bias:0', 'tf_bert
_model_1/bert/pooler/dense/kernel:0', 'tf_bert_model_1/bert/pooler/dense/bia
s:0'] when minimizing the loss.
WARNING:tensorflow:Gradients do not exist for variables ['tf_bert_model/ber
t/pooler/dense/kernel:0', 'tf_bert_model/bert/pooler/dense/bias:0', 'tf_bert
_model_1/bert/pooler/dense/kernel:0', 'tf_bert_model_1/bert/pooler/dense/bia
s:0'] when minimizing the loss.
WARNING:tensorflow:Gradients do not exist for variables ['tf_bert_model/ber
t/pooler/dense/kernel:0', 'tf_bert_model/bert/pooler/dense/bias:0', 'tf_bert
_model_1/bert/pooler/dense/kernel:0', 'tf_bert_model_1/bert/pooler/dense/bia
s:0'] when minimizing the loss.
1621/1621 [==============================] - 729s 450ms/step - loss: 0.3912
Epoch 2/2
1621/1621 [==============================] - 729s 450ms/step - loss: 0.3628
validation score =  0.39250637350566875
Epoch 1/2
WARNING:tensorflow:Gradients do not exist for variables ['tf_bert_model/ber
t/pooler/dense/kernel:0', 'tf_bert_model/bert/pooler/dense/bias:0', 'tf_bert
_model_1/bert/pooler/dense/kernel:0', 'tf_bert_model_1/bert/pooler/dense/bia
```

```
s:0'] when minimizing the loss.
WARNING:tensorflow:Gradients do not exist for variables ['tf_bert_model/ber
t/pooler/dense/kernel:0', 'tf_bert_model/bert/pooler/dense/bias:0', 'tf_bert
_model_1/bert/pooler/dense/kernel:0', 'tf_bert_model_1/bert/pooler/dense/bia
s:0'] when minimizing the loss.
WARNING:tensorflow:Gradients do not exist for variables ['tf_bert_model/ber
t/pooler/dense/kernel:0', 'tf_bert_model/bert/pooler/dense/bias:0', 'tf_bert
_model_1/bert/pooler/dense/kernel:0', 'tf_bert_model_1/bert/pooler/dense/bia
s:0'] when minimizing the loss.
WARNING:tensorflow:Gradients do not exist for variables ['tf_bert_model/ber
t/pooler/dense/kernel:0', 'tf_bert_model/bert/pooler/dense/bias:0', 'tf_bert
_model_1/bert/pooler/dense/kernel:0', 'tf_bert_model_1/bert/pooler/dense/bia
s:0'] when minimizing the loss.
1622/1622 [==============================] - 769s 474ms/step - loss: 0.3906
Epoch 2/2
1622/1622 [==============================] - 769s 474ms/step - loss: 0.3628
validation score =  0.3799584801919352
```

Error Analysis of Feature in a Datapoint

In [106]:

```
targets = list(sample_submission.columns[1:])
targets
```

Out[106]:

```
['question_asker_intent_understanding',
 'question_body_critical',
 'question_conversational',
 'question_expect_short_answer',
 'question_fact_seeking',
 'question_has_commonly_accepted_answer',
 'question_interestingness_others',
 'question_interestingness_self',
 'question_multi_intent',
 'question_not_really_a_question',
 'question_opinion_seeking',
 'question_type_choice',
 'question_type_compare',
 'question_type_consequence',
 'question_type_definition',
 'question_type_entity',
 'question_type_instructions',
 'question_type_procedure',
 'question_type_reason_explanation',
 'question_type_spelling',
 'question_well_written',
 'answer_helpful',
 'answer_level_of_information',
 'answer_plausible',
 'answer_relevance',
 'answer_satisfaction',
 'answer_type_instructions',
 'answer_type_procedure',
 'answer_type_reason_explanation',
 'answer_well_written']
```

In [107]:

```
print(project_data_cv.shape)
print(result_data_cv.shape)
```

```
(1216, 11)
(1216, 30)
```

In [108]:

```
pred_input = compute_input_Bert(project_data_cv, project_data_cv.columns, tokenizer, MAX_SE
true_output = compute_output_arrays(result_data_cv, result_data_cv.columns)
```

```
1216it [00:09, 124.47it/s]
```

In [109]:

```
predicted_output = model.predict(pred_input)
```

In [110]:

```
print(true_output.shape)
print(predicted_output.shape)
```

```
(1216, 30)
(1216, 30)
```

In [111]:

```
pred_dataframe = pd.DataFrame(data=predicted_output, columns=targets)
print(pred_dataframe.shape)
print(pred_dataframe.head())
```

```
(1216, 30)
   question_asker_intent_understanding  ...  answer_well_written
0                             0.956452  ...             0.917855
1                             0.858519  ...             0.890307
2                             0.884348  ...             0.913173
3                             0.852427  ...             0.894467
4                             0.802341  ...             0.911586

[5 rows x 30 columns]
```

In [112]:

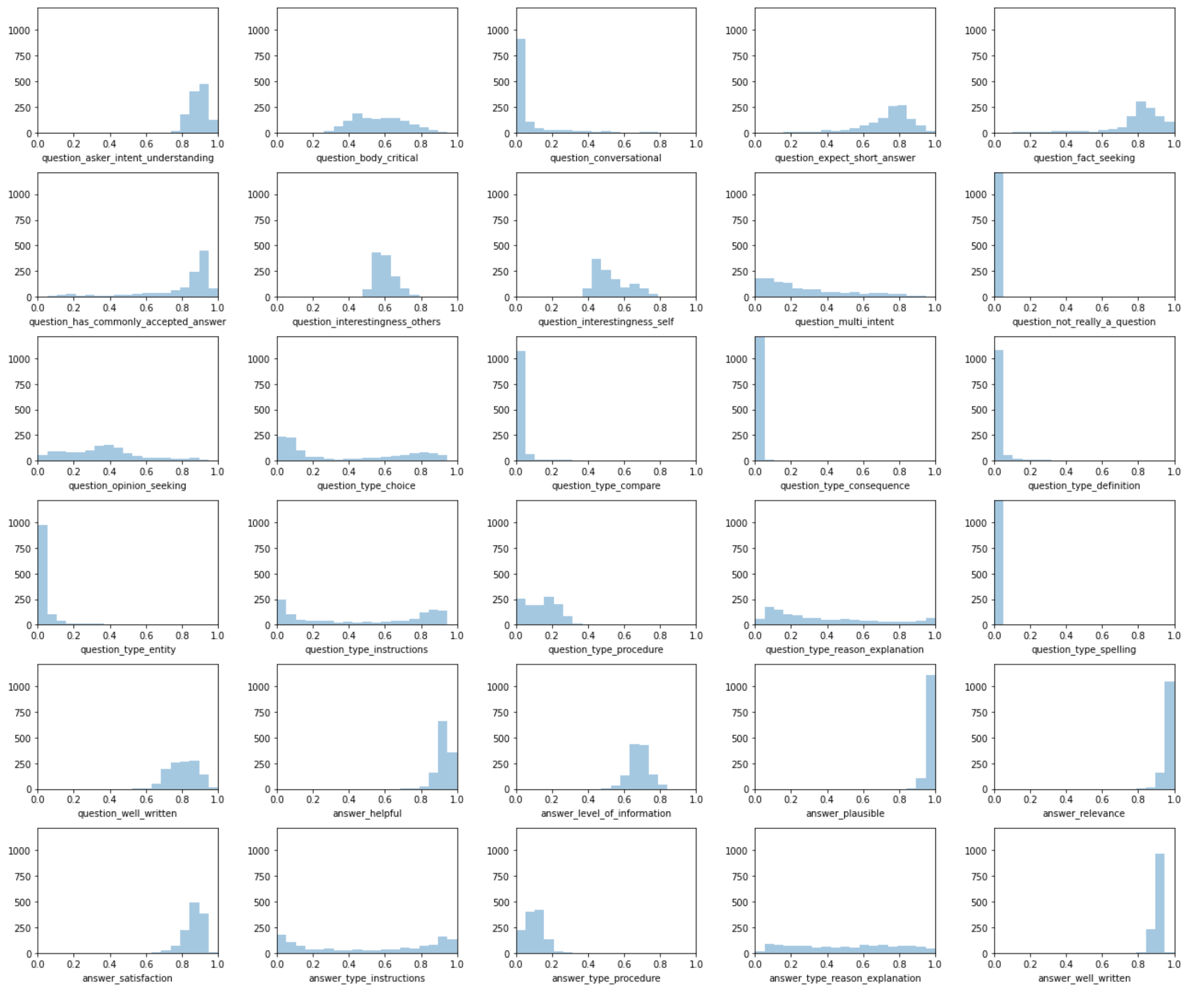
```
actual_dataframe = pd.DataFrame(data=true_output, columns=targets)
print(actual_dataframe.shape)
print(actual_dataframe.head())
```

```
(1216, 30)
   question_asker_intent_understanding  ...  answer_well_written
0                             1.000000  ...             1.000000
1                             0.888889  ...             0.888889
2                             0.777778  ...             1.000000
3                             0.888889  ...             0.833333
4                             0.333333  ...             1.000000

[5 rows x 30 columns]
```

Distribution of Target variables in Predicted Data

In [113]:

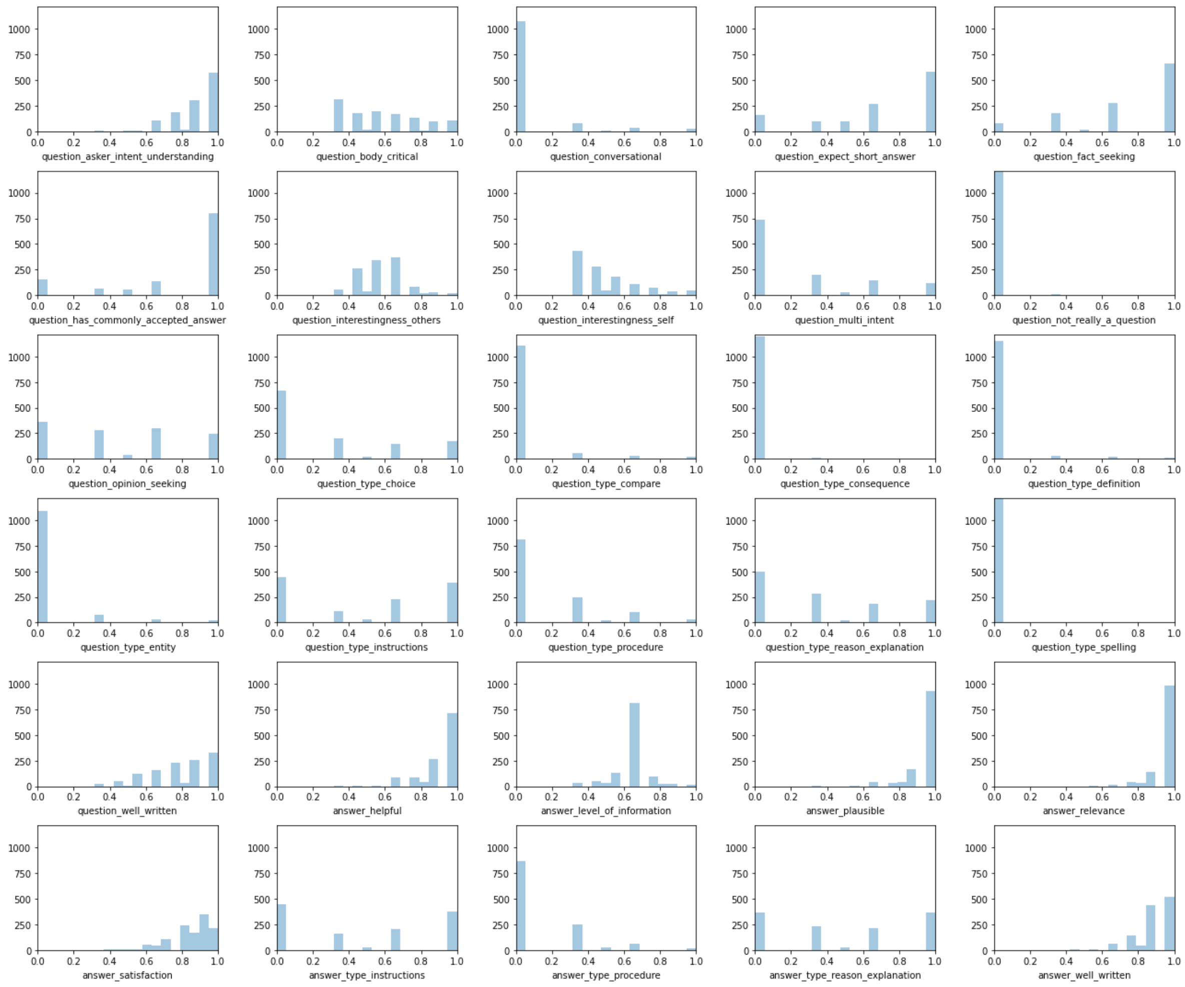
```
fig, axes = plt.subplots(6, 5, figsize=(18, 15))
axes = axes.ravel()
bins = np.linspace(0, 1, 20)

for i, col in enumerate(targets):
    ax = axes[i]
    sns.distplot(pred_dataframe[col], label=col, kde=False, bins=bins, ax=ax)
    # ax.set_title(col)
    ax.set_xlim([0, 1])
    ax.set_ylim([0, 1216])
plt.tight_layout()
plt.show()
plt.close()
```



Distribution of Target variables in Actual Data

In [114]:

```python
fig, axes = plt.subplots(6, 5, figsize=(18, 15))
axes = axes.ravel()
bins = np.linspace(0, 1, 20)

for i, col in enumerate(targets):
    ax = axes[i]
    sns.distplot(actual_dataframe[col], label=col, kde=False, bins=bins, ax=ax)
    # ax.set_title(col)
    ax.set_xlim([0, 1])
    ax.set_ylim([0, 1216])
plt.tight_layout()
plt.show()
plt.close()
```



Conclusion from distribution of predicted and Actual

1. Above Plot is a distribution plot of actual and predicted output from the best Bert Model

2. From the Distribution we can Conclude that Most of the Feature is Predicted good and thier ranges between 0-1 is almost same .
3. Some Feature like question_fact_seeking ,question_multi_intent is differ by the Range 0.1 otherwise every feature is almost in same range.

In [115]:

```
print(true_output.shape)
print(predicted_output.shape)
```

```
(1216, 30)
(1216, 30)
```

In [116]:

```
len(targets)
```

Out[116]:

```
30
```

Spearman Correaltion of Each Feature in a Datapoint

In [117]:

```
for i in range(len(targets)):
  print("Spearman Correaltion in Feature {row} ".format(row = i+1),spearmanr(true_output[:,
  print("=="*62)
```

```
Spearman Correaltion in Feature 1  0.40993690025303725
============================================================================
================================================
Spearman Correaltion in Feature 2  0.6404288846769483
============================================================================
================================================
Spearman Correaltion in Feature 3  0.46452270891265374
============================================================================
================================================
Spearman Correaltion in Feature 4  0.44794321325992564
============================================================================
================================================
Spearman Correaltion in Feature 5  0.4802539013110392
============================================================================
================================================
Spearman Correaltion in Feature 6  0.5701283805494901
============================================================================
================================================
Spearman Correaltion in Feature 7  0.3887799613620518
============================================================================
================================================
Spearman Correaltion in Feature 8  0.5495861660647166
============================================================================
================================================
Spearman Correaltion in Feature 9  0.6490617935760808
============================================================================
================================================
Spearman Correaltion in Feature 10  0.10985602426047784
============================================================================
================================================
Spearman Correaltion in Feature 11  0.6246258208058679
============================================================================
================================================
Spearman Correaltion in Feature 12  0.7927164093863606
============================================================================
================================================
Spearman Correaltion in Feature 13  0.4347532567030249
============================================================================
================================================
Spearman Correaltion in Feature 14  0.17863718762349037
============================================================================
================================================
Spearman Correaltion in Feature 15  0.362592149532066
============================================================================
================================================
Spearman Correaltion in Feature 16  0.4689497017776372
============================================================================
================================================
Spearman Correaltion in Feature 17  0.8349960893622543
============================================================================
================================================
Spearman Correaltion in Feature 18  0.43162829628339566
============================================================================
================================================
Spearman Correaltion in Feature 19  0.743645058019185
============================================================================
================================================
Spearman Correaltion in Feature 20  0.047851543988731246
============================================================================
================================================
Spearman Correaltion in Feature 21  0.5858758032776122
============================================================================
================================================
Spearman Correaltion in Feature 22  0.2935987809189765
============================================================================
================================================
Spearman Correaltion in Feature 23  0.45252061251311304
============================================================================
================================================
Spearman Correaltion in Feature 24  0.20021171712277008
============================================================================
================================================
Spearman Correaltion in Feature 25  0.2290612285671603
============================================================================
================================================
Spearman Correaltion in Feature 26  0.39596088281715486
============================================================================
================================================
Spearman Correaltion in Feature 27  0.8237219682640756
============================================================================
================================================
Spearman Correaltion in Feature 28  0.3737815564815884
============================================================================
================================================
Spearman Correaltion in Feature 29  0.8045721487568949
============================================================================
================================================
Spearman Correaltion in Feature 30  0.2938000072794169
============================================================================
================================================
```

Conclusion from Spearman Correaltion of Each Feature in a Datapoint

```
The Spearmen Correaltion of Feature qyestion_type_instruction is the best among all and
getting 0.83 value. These features is predicting the output pretty well. so We can
Conclude that these are the Feature which are contributing to overall mean of spearman
value of each data point.
Question_not_really_ question has less value of Spearmen Correaltion of 0.10 and
Rest all is perfoming pretty good
```

In [118]:

```
print(true_output.shape)
print(predicted_output.shape)
```

```
(1216, 30)
(1216, 30)
```

In [119]:

```
mse = tf.keras.losses.MeanSquaredError()
mae = tf.keras.losses.MeanAbsoluteError()
mape = tf.keras.losses.MeanAbsolutePercentageError()
bce = tf.keras.losses.BinaryCrossentropy()
```

Getting Mean Squared Error , Mean Absolute Error ,Mean Absolute Percentage Error, Binary Cross Entropy Error in each Data point in Predicted Value

In [120]:

```
for i in range(len(predicted_output)):
  print("Mean Squared Error Error in {row} Data Point".format(row = i+1),mse(predicted_outp
  print("Mean Absolute Error Error in {row} Data Point".format(row = i+1),mae(predicted_out
  print("Mean Absolute Percentage Error Error in {row} Data Point".format(row = i+1),mape(p
  print("Binary Cross Entropy Error in {row} Data Point".format(row = i+1),bce(predicted_ou
  print("=="*62)
```

```
Streaming output truncated to the last 5000 lines.
Mean Absolute Error Error in 217 Data Point 0.12445047497749329
Mean Absolute Percentage Error Error in 217 Data Point 55.72272491455078
Binary Cross Entropy Error in 217 Data Point 1.4689544439315796
==========================================================================
==================================================
Mean Squared Error Error in 218 Data Point 0.04910821467638016
Mean Absolute Error Error in 218 Data Point 0.1230667233467102
Mean Absolute Percentage Error Error in 218 Data Point 54.950096130371094
Binary Cross Entropy Error in 218 Data Point 1.5248781442642212
==========================================================================
==================================================
Mean Squared Error Error in 219 Data Point 0.059019699692726135
Mean Absolute Error Error in 219 Data Point 0.16596929728984833
Mean Absolute Percentage Error Error in 219 Data Point 100.22526550292969
Binary Cross Entropy Error in 219 Data Point 1.2345609664916992
==========================================================================
==================================================
Mean Squared Error Error in 220 Data Point 0.0161060132086277
```

Conclusion From Error Analysis of Feature in a Datapoint

Conclusion from distribution of predicted and Actual

1. Above Plot is a distribution plot of actual and predicted output from the best Bert Model
2. From the Distribution we can Conclude that Most of the Feature is Predicted good and thier ranges between 0-1 is almost same .
3. Some Feature like question_fact_seeking ,question_multi_intent is differ by the Range 0.1 otherwise every feature is almost in same range.

Conclusion from Spearman Correaltion of Each Feature in a Datapoint

The Spearmen Correaltion of Feature qyestion_type_instruction is the best among all and getting 0.83 value. These features is predicting the output pretty well. so We can Conclude that these are the Feature which are contributing to overall mean of spearman value of each data point. Question_not_really_ question has less value of Spearmen Correaltion of 0.10 and Rest all is perfoming pretty good

In [ ]:

```

```